

A-1

Core Patterns for Brine Wells No. 1 and No. 2.

# CORE RECORD

Company:

Well: BRINE WELL #1

Loc:

Elev:

Date:

CORE NO.	FROM	TO	RECOVERY	FORMATION	SHOWING	TYPE BARREL
3			HRS.	SPUD: 6-15-42		BIT No 1
1	0	12		Top of Ground to Top of Rotary		
689	12	25	1 1/2	Black Clay		
676	25	85		Sand & Gravel		
616	85	110	3	Hard Sand		
591	110	170		Brkn Hard sand		
531	170	215		" " " Shale & Lime		
486	215	218		Black shale		
1	218	224		Coal		
1	224	230		Dark carbonaceous sandy shale		
	230	265		Sandy shale & Lim		
	265	350		" " " "		
BIT RECORD						
SET 319.16 of 1378 @ 326.89 w/ 175 SX						
	350	374		Shale & Lime	BIT No 4	FROM 350 TO 405
	374	420		Shale & Sand	7	405 490 20%
	420	545	8	" " "	8	490 1200 17
	545	628		Shale	9	1200 1325 14 3/4
	628	645	6	"	10	1325 1410 9 3/4
	645	778		Sandy shale & Lime Brkn	11	1410
	778	800	15	Sandy shale		
	800	865	6 1/2	Broken Sand		
	865	912				

# CORE RECORD

Company:

Well: BRINE No. 1

Loc:

Elev:

Date:

CORE NO.	FROM	TO	RECOVERY	FORMATION	SHOWING	TYPE BARREL
	865	912		Sandy shale & Lim		
	912	1006	7 1/2	" " "		
	1006	1077	7 1/2	Broken Sand & Shale		
	1077	1190	8	Sandy shale & Lime		
	1090	1208	1 1/4	Sand & Lime		
	1208	1221	8	Sandy Lime		
	1221	1286		Sandy Lime & Shale		
	1286	1298		" " " "		
	1298	1320	6 10	Hard Sand		
	1320	1332		Sandy shale & Lime		
	1332	1407	4	Lime & Hard Sand		
	1407	1425		Hard Sand		

OS III Class

Central File Copy



STATE OF WEST VIRGINIA  
DEPARTMENT OF MINES  
OIL AND GAS DIVISION

## WELL RECORD

Permit No. MARS-135Oil or Gas Well Salt  
(KIND)

Company Pittsburgh Plate Glass Company  
Address New Martinsville, W. Va.  
Farm Defense Plant Corporation Acres 225  
Location (waters) E. bank of Ohio River near Proctor  
Well No. 2 Elev. 710.0  
District Franklin County Marshall  
The surface of tract is owned in fee by Defense Plant Corp.  
Address Washington, D.C.

Mineral rights are owned by \_\_\_\_\_

Address \_\_\_\_\_

Drilling commenced October 3, 1942Drilling completed December 21, 1942

Date Shot \_\_\_\_\_ From \_\_\_\_\_ To \_\_\_\_\_

With \_\_\_\_\_

Flow \_\_\_\_\_ /10ths Water in \_\_\_\_\_ Inch

\_\_\_\_\_ /10ths Merc. in \_\_\_\_\_ Inch

Slime \_\_\_\_\_ Cu. Ft.

Rock Pressure \_\_\_\_\_ lbs. \_\_\_\_\_ hrs.

Oil \_\_\_\_\_ bbls., 1st 24 hrs.

Fresh water \_\_\_\_\_ feet \_\_\_\_\_ feet

Salt water \_\_\_\_\_ feet \_\_\_\_\_ feet

Casing and Tubing	Used in Drilling	Left in Well	Packers
Size			
16			Kind of Packer
18			
<del>11-3/4</del>		892	Size of
<del>8-5/8</del>		6,495	
8 1/2			Depth set
5 3/8			
<del>4-1/2</del>		6,859	Perf. top
2			Perf. bottom
Liners Used			Perf. top
2 1/2			Perf. bottom

CASING CEMENTED Yes SIZE 8-5/8 No. Ft. 2,000 Date12-17-42COAL WAS ENCOUNTERED AT 242 FEET 0 INCHES

FEET INCHES FEET INCHES

FEET INCHES FEET INCHES

Formation	Color	Hard or Soft	Top	Bottom	Oil, Gas or Water	Depth Found	Remarks
Rotary Table			0	12.5			
Clay		Soft	12.5	28			
Sand & Gravel		"	28	80			
Shale & Shells		"	80	242			
Coal		"	242	247			
Shale		"	247	270			
Shale & Shells		"	270	370			
Shale		Hard	370	580			
Shale & Shells		"	580	640			
Red Bed &							
Sand		"	640	700			
Shale		"	700	809			
Sand &		"					
Sandy Shale		"	809	842			
Sand & Shell		"	842	880			
Shale		"	880	920			
Sandy Shale &		"					
Lime		"	920	946			
Sandy Shale &		"					
Sand		"	946	980			
Hard Sandy		"					
Shale & Lime		"	980	1055			
Sandy Lime		"	1055	1075			

Organics and TOC analyses and comparisons for mercury pond and downgradient wells.

- Purpose - To show that the impoundment is not the source of organic contamination in monitoring wells.
- Attached pages consist of the following:
  - Page 1 - Summary of TOC and TOX analyses performed in late 1983 and early 1984.
  - Page 2 - Table 2 of Geraghty and Miller report (December, 1983) which contains results of analyses done on October 19 and October 27, 1983, samples. (Note that TOC and TOX values in this table are contained in the Page 1 summary.)
  - Page 3 - Attachment III to state RCRA inspection report dated November 29, 1983, which shows August 3, 1983, analyses for downgradient wells GM-1 and GM-6. (Note that TOC and TOX values in this table are contained in the Page 1 summary.)
  - Pages 4, 5 - March 26, 1984, analyses (of March 23, 1984, samples) of organics in the mercury pond influent. (Note that these values are contained in the Page 1 summary.) As can be noted, the organics content was quite low for this sample. The Laboratory was asked to look for the particular organic component and when the component is reported as less than ( ), it is an indication that none could be found due to background level noise (below level of detection).
- Companion samples for the impoundment and the monitoring wells were not available in many instances.
- For TOC the samples for 8/3/83 were taken as parallel samples during the DNR inspection (under EPA contract). The data for the 10/19/83 and 10/27/83 samples were taken as part of the Phase I water quality assessment at the PPG mercury pond to explain the significant differences obtained under the RCRA water monitoring program.
- The Halo-Organic and Benzene analyses on the summary are from two sources. The 8/3/83 figures are the results reported by the EPA for the inspection mentioned earlier. The data for 3/23/84 were the results obtained by the Natrium Laboratory for comparison with monitoring well analysis.

# SUMMARY

## TOC

(Analysis in ppm)

	<u>8/3/83</u>	<u>10/19/83</u>	<u>10/27/83</u>
Hg Pond	--	4.0	3.9
GM-1	12	9.0	8.1
GM-2	--	5.7	3.1
GM-6	--	7.4	5.5

## Halo-Org & Benzene

(analysis in ppb)

	<u>8-3-83 EPA</u>		<u>Natrium Mercury Pond</u>
	<u>GM-1</u> <i>Meyers</i>	<u>GM-6</u>	<u>3/23/84</u>
Methylene Chloride	10 6.1	11.1	4
Trans-1,2-Dichloroethane	ND <2	ND	<1
Chloroform	.916 <2	1.60	6
Cis-1,2-Dichloroethane	25.4 <2	53.4	<1
Carbon Tetrachloride	1.27 <2	2.12	<1
Benzene	4.10 <2	7.0	20
Trichloroethane	10.7	24.2	3.0
1,1,2-Trichloroethane	11.0	24.5	<1
Tetrachloroethane	28.9	26.0	3
Bromoform	3.40	5.91	<1
1,4-Dichlorobenzene	5.0	8.0	<10
1,2-Dichlorobenzene	10.1	15.7	<10
1,1-Dichloroethane	ND	ND	<1
1,1,1-Trichloroethane	.688	ND	<1
1,2-Dichloroethane	25.4	53.4	<1
Monochlorobenzene	ND	ND	<10
1,1,2,2-Tetrachloroethane	ND	ND	<10
1,3-Dichlorobenzene	ND	ND	<10
Hexachloroethane	ND	ND	<10
1,2,4-Trichlorobenzene	ND	ND	<10
1,2,3-Trichlorobenzene	ND	ND	<10
Unknowns			<10
Volatiles	ND	ND	
Aromatics	ND	ND	

ND = none detected

Analytical method on following laboratory report

# SUMMARY

## TOC

(Analysis in ppm)

	<u>8/3/83</u>	<u>10/19/83</u>	<u>10/27/83</u>
Hg Pond	--	4.0	3.9
GM-1	12	9.0	8.1
GM-2	--	5.7	3.1
GM-6	--	7.4	5.5

## Halo-Org & Benzene

(analysis in ppb)

	<u>8-3-83 EPA</u>		<u>Natrium Mercury Pond</u>
	<u>GM-1</u>	<u>GM-6</u>	<u>3/23/84</u>
Methylene Chloride	10	11.1	4 ✓
Trans-1,2-Dichloroethane	ND	ND	<1
Chloroform	.916	1.60	6 ✓
Cis-1,2-Dichloroethane	25.4	53.4	<1
Carbon Tetrachloride	1.27	2.12	<1
Benzene	4.10	7.0	20 ✓
Trichloroethane	10.7	24.2	3.0
1,1,2-Trichloroethane	11.0	24.5	<1
Tetrachloroethane	28.9	26.0	3
Bromoform	3.40	5.91	<1
1,4-Dichlorobenzene	5.0	8.0	<10
1,2-Dichlorobenzene	10.1	15.7	<10
1,1-Dichloroethane	ND	ND	<1
1,1,1-Trichloroethane	.688	ND	<1
1,2-Dichloroethane	25.4	53.4	<1
Monochlorobenzene	ND	ND	<10
1,1,2,2-Tetrachloroethane	ND	ND	<10
1,3-Dichlorobenzene	ND	ND	<10
Hexachloroethane	ND	ND	<10
1,2,4-Trichlorobenzene	ND	ND	<10
1,2,3-Trichlorobenzene	ND	ND	<10
Unknowns			<10
Volatiles	ND	ND	
Aromatics	ND	ND	

ND = none detected

Analytical method on following laboratory report

TABLE 2.  
RESULTS OF CHEMICAL ANALYSES CONDUCTED DURING THE PHASE I WATER-QUALITY ASSESSMENT  
AT THE PPG MERCURY POND  
(all values are expressed in mg/l unless otherwise specified)

Well Location	pH (std. units)	SC (umhos/cm)	TOC	TDS	Total ALK. (as CaCO <sub>3</sub> )	HCO <sub>3</sub>	Cl	SO <sub>4</sub>	Na	K	Ca	Mg	Fe	Mn	SiO <sub>2</sub>	Hg (ug/l)	Na/Cl
<u>10/19/83 Sample Set</u>																	
GM-0	6.9	678	1.2	425	212	259	19	84	-	-	-	-	-	-	-	-	-
GM-1	7.1	1158	9.0	650	602	734	18	<10	122	1.4	100	29	0.1	1.0	11.5	<0.5	6.8
GM-2	7.0	1355	5.7	758	596	727	79	<10	172	3.0	99	23	0.9	1.7	13.4	<0.5	2.2
GM-6	7.3	1050	7.4	635	207	253	61	188	97	2.7	98	16	<0.1	0.7	8.5	<0.5	1.6
Hg Pond	11.6	91625	4.0	85950	1424	1737	49000	1640	35200	19.4	13	<1	<0.1	<0.02	31.4	347	0.72
<u>10/27/83 Sample Set</u>																	
GM-0	7.1	719	1.4	485	202	246	27	84	-	-	-	-	-	-	-	-	-
GM-1	7.2	1178	8.1	675	599	731	49	<10	123	1.5	103	28	10.7	1.1	11.8	0.5	2.5
GM-2	7.0	1369	3.1	743	579	706	84	<10	203	3.2	92	21	5.1	1.5	13.8	<0.5	2.4
GM-6	7.2	1055	5.5	610	202	246	69	177	X	X	X	X	X	X	X	X	X
Hg Pond	12.0	61500	3.9	52400	5854	7142	29000	840	22000	17.4	16	1	0.1	<0.02	19.3	350	0.76
<u>Mean Average of 10/19/83 and 10/27/83 Data</u>																	
GM-0	7.0	699	1.3	455	207	253	23	84	-	-	-	-	-	-	-	-	-
GM-1	7.2	1168	8.6	663	601	733	34	<10	123	1.5	102	29	5.4	1.1	11.7	<0.5	3.6
GM-2	7.0	1362	4.4	751	588	717	82	<10	188	3.1	96	22	3.0	1.6	13.6	<0.5	2.3
GM-6	7.3	1053	6.5	623	205	250	65	183	97*	2.7*	98*	16*	<0.1*	0.7*	8.5*	<0.5*	1.6*
Hg Pond	11.8	76563	4.0	69175	3639	4440	39000	1240	28600	18.4	15	<1	<0.1	<0.02	25.4	349	0.73

- Not analyzed

X Insufficient sample volume for analyses

\* Value based entirely on 10/19/83 data

ATTACHMENT III

Surface Impoundment  
 ... West Virginia  
 Samples collected on August 3, 1983

Chemical Analyses

(Analyses in mg/l unless otherwise stated)

Parameter	<u>Sampling Point</u>		
	GM-0	GM-1	GM-6
TOC	2	12	N.T.F.
Chloride	27	27	N.T.F.
Sulfate	121	1	N.T.F.
*Phenolics	1	4	N.T.F.
*Arsenic	<2	20	3
Lead	<.01	.03	.04
Barium	.06	1.2	.24
Cadmium	.001	.002	.003
*Mercury	<.1	.23	<.1

\*Analyses in µg/l  
 N.T.F. = Not Tested For

(Analyses in µg/l)

Parameter	<u>Sampling Point</u>			
	Field Blank	GM-0	GM-1	GM-6
Methylene Chloride	N.D.	1.78	10	11.1
1,2-Dichloroethene	N.D.	N.D.	25.4	53.4
1,1,1-Trichloroethane	N.D.	N.D.	.688	N.D.
1,1,2-Trichloroethane	N.D.	N.D.	11.0	24.5
Bromoform	N.D.	N.D.	3.40	5.91
Tetrachloroethene	N.D.	51.0	28.9	26.0
Chloroform	N.D.	N.D.	.916	1.60
Carbon Tetrachloride	N.D.	N.D.	1.27	2.12
Trichloroethene	N.D.	7.91	10.7	24.2
Benzene	N.D.	N.D.	4.10	7.0
1,4 Dichlorobenzene	N.D.	N.D.	5.0	8.0
1,2-Dichlorobenzene	N.D.	N.D.	10.1	15.7
Volatiles	N.D.	N.D.	N.D.	N.D.
Aromatics	N.D.	N.D.	N.D.	N.D.

N.D. = None Detected

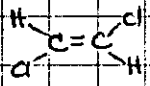
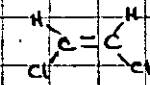

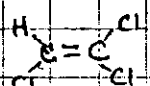
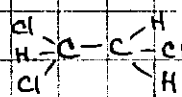
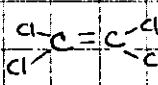




PPG INDUSTRIES, INC.  
Chemical Division — Natrium  
LABORATORY DEPT.

9C

C Rec'd.: 3-23-84 W.O. # 635520  
Type Sample: Mercury Pond Influent H<sub>2</sub>O Sample No.:             
Submitted By: K. Walborn Dept.: Environmental  
Report To: K. Walborn Date Reported: 3-26-84  
Notebook No.: Lab file; book 1499 Page No.: 88

Analysis Required: Concn. of specific halo-organics + benzene

Component	Formula	Concn, ppb	Method
Methylene chloride	<chem>CH2Cl2</chem>	4.	1
Trans-1,2-dichloroethene		< 1.	1
Chloroform	<chem>CHCl3</chem>	6.	1
Cis-1,2-dichloroethene		< 1.	1
Carbon tetrachloride	<chem>CCl4</chem>	< 1.	1
Benzene		20.	3
Trichloroethene		3.	1
1,1,2-Trichloroethane		< 1.	1
Tetrachloroethene		3.	1
Bromoform	<chem>CHBr3</chem>	< 1.	2
1,4-Dichlorobenzene		< 10.	3
1,2-Dichlorobenzene		< 10.	3

Methods:

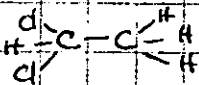
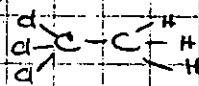
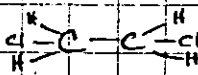

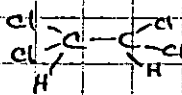

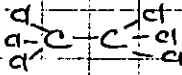


- 1 Headspace/Tracor G/C - Packed column - Hall detector
- 2 Headspace/Shimadzu G/C - Packed column - EC detector
- 3 CS<sub>2</sub> extraction/Shimadzu GC - Capillary column - FID detector

A-1  
Page

PPG INDUSTRIES, INC.  
Chemical Division — Natrium  
LABORATORY DEPT.

Date Rec'd.: 3-23-84 W.O. # 635520  
Sample: Mercury Pond Influent H<sub>2</sub>O Sample No.:         
Submitted By: K. Walborn Dept.: Environmental  
Report To: K. Walborn Date Reported: 3-26-84  
Notebook No.: Lab file; Book 1499 Page No.: 88

Analysis Required: Non-requested components/unknowns found/analyzed for during organics analysis.

Component	Formula	Concn, ppb	Method
1,1-dichloroethane		< 1.	1
1,1,1-trichloroethane		< 1.	1
1,2-dichloroethane		< 1.	1
Monochlorobenzene		< 10.	3
1,1,2,2-tetrachloroethane		< 10.	3
1,3-dichlorobenzene		< 10.	3
Hexachloroethane		< 10.	3
1,2,4-trichlorobenzene		< 10.	3
1,2,3-trichlorobenzene		< 10.	3
Unknowns (1)		< 10	3

Signed: J. Bogdan

(Page 2 of 2) <sup>A-1</sup> <sub>Rele</sub>

A-3

Perched zone water analyses (1981-1983).

- Attached for perched zone Wells GM-5 and GM-7 - no water was obtained at GM-3. Some of these analyses reflect testing for background levels under RCRA.

FFG INDUSTRIES  
Chemical Division - NATION  
LABORATORY DEPT.

Well No GM-5

Date Rec'd.: See Back

Sample: Water DEPT. ENV.

Submitted By: C. Drum

Report To: C. Drum

DATE

ANALYSIS REQUIRED	GUIDE LIMITS	11/13/80	Nov 1981	May 1982	Jun 1982	Nov 1982	Apr 83	Aug 83
pH	✓6.5-8.5	7.9	7.2 7.2 7.2 7.2	7.1 7.1 7.1 7.1	7.1 7.2 7.1 7.2	7.2 7.2 7.2 7.2	7.1 7.1 7.1 7.1	7.1 7.1 7.1 7.2
(Micro Mhoc) Specific Conductance 25°C			730 720 720 730	4x700	715 737 750 767	765 744 733 731	794 797 794 796	4x800
TOC mg/l		9.0	10.9 11.1 11.1 13.1	1.3 1.2 1.2 1.2	1.0 1.2 1.1 1.2	3.2 3.1 3.1 3.1	5.6 5.7 5.7 5.7	4.6 4.4 4.3 4.4
TOX µg/l Cl			4x<40	120 80 60 20	70 30 80 20	160 90 168 110	70 90 70 110	160 170 170 170
Cl mg/l	✓250 mg/l	39	72	30	35	41	35	29
mg/l	✓250 mg/l	81	63	58	60	52	67	55
Fe mg/l	✓.3 mg/l	<.1	16.3	.4	2.4	3.2	2.3	.2
Mn mg/l	✓.05 mg/l	.012	1.6	.4	1.8	1.2	1.6	.4
Na mg/l		51.9	46	36	130	48	49	40
enol mg/l			.02	.02	.006	.003	.02	.007
AsT mg/l	*.05 mg/l±5.mg/l	.005	.01	.005	.007	.005		.005
BaT mg/l	*1.mg/l±100mg/l	.10	.45	.13	.43	.27		.14
CdT mg/l	*.01mg/l±1.mg/l	.005	.01	.004	.089	.01		.001
CrT mg/l	*.05mg/l±5.mg/l	<.01	.01	.012	.021	.01		
mg/l	*.05mg/l±5.mg/l	.005	.09	.006	.083	.020		.005
mg/l	*.002mg/l±.2mg/l	.0005	.001	.0006	.0001	.0005	.0002	.0002
SeT mg/l	*.010mg/l±1.mg/l	.005	.005	.005	.005	.005		
AgT mg/l	*.05mg/l±5.mg/l	.005	.010	.004	.011	.010		
Nitrate (N) mg/l	.10 mg/l		.48	.5	.42	.24		
F mg/l	*2.4 mg/l	.6	.6	1	1	1		
Endrin mg/l	*.0002 mg/l±.02 mg/l		.0002	.0002	.0002	.0002		
Lindane mg/l	*.004 mg/l±.4 mg/l		.0001	.004	.004	.004		
Methoxychlor mg/l	*.1 mg/l±10 mg/l		.003	.005	.1	.1		
Toxaphene mg/l	*.005 mg/l±.5 mg/l		.003	.005	.005	.005		
2,4,D mg/l	*.1 mg/l±10 mg/l		.01	.01	.1	.1		
.5.7p Silvex mg/l	*.01 mg/l±1. mg/l		.01	.01	.01	.01		

Based on Primary Drinking Water Standards.

Retranscribed K Walborn 4/5/84

Chemical Division — NATION  
LABORATORY DEPT.

Well No GM-5

Rec'd.: See Back

Type Sample: Water DEPT. ENV.

Submitted By: C. Drum

Report To: C. Drum

DATE

ANALYSIS REQUIRED	GUIDE LIMITS	11/13/80	Nov 1981	May 1982	Jun 1982	Nov 1982	Apr 83	Aug 83
Radium 226 pCi/l	5. pCi/l		.9	1.3	.6	1		
Radium 228 pCi/l			1	1	1	1		
Gross Alpha pCi/l	*2. pCi/l		<2	<2	<2	<2		
Gross Beta pCi/l	* dose 4m-rem./yr.		<3	<3	7	<5		
Turbidity J.T.U.	*1 to 5		1500	220	140	292		
Coliform Bact. Colonies/100	*M.F. 4 colonies/100		700	<20	<5	<1		
Alkalinity (as CaCO <sub>3</sub> ) mg/l		235	566	313	296	297	313	326
Alkalinity as HCO <sub>3</sub> mg/l		287		382	361	356	382	398
Color APHA	√15	5	25	0	5	5	0	0
TDS mg/l	√500 mg/l	338	432	478	435	438	445	438
Ca mg/l		84.7	114	100	154	104	141	97
Mg mg/l	√1 mg/l	<.1	.11	.008	.022	.03	.03	.01
K mg/l		2.6	7.1	1.7	3.2	2.0	2.3	1.9
Zn mg/l	√5 mg/l	<.1	<.1	<.02	.12	.2	.1	.1
Mg mg/l		10.6	22.8	20.7	30.1	22.7	26.7	22.5
V mg/l			.075	.010	.020	.010	.02	.01

Tested on Primary Drinking Water Standards.

Determined by 11/13/80

FFG INDUSTRIES  
Chemical Division - Natrium  
LABORATORY DEPT.

Well No GM-7

Site No.: See Back

Sample: Water

DEPT. ENV

Submitted By: C. Drum

Report To: C. Drum

DATE

ANALYSIS REQUIRED	GUIDE LIMITS	9/1/81	Nov 1981	Mar 1982	June 1982	Nov 1982	Apr 1983	Aug 1983
pH	6.5-8.5	7.4	7.4x	6.8 4x	6.9 4x	6.9 4x	6.8 4x	6.9 7.0 6.9 7.0
(Micro Rhoc) Specific Conductance 25°C		1016 1040 1030 1020	790 790 770 800	900 4x	867 940 803 802	820 846 855 860	932 934 934 934	1350 4x
TOC mg/l		14.7 22.9 19.7 163	9.6 12.1 6.9 6.7	1.4 1.3 1.3 1.3	13.2 12 12.3 12	2.2 2.1 2.2 2.4	17.7 125 17.8 125	6.5 6.1 6.2 6.2
TOX mg/l Cl		39	20 4x	20 4x	20 4x	20 4x	50 4x	70 80 70 80
Cl mg/l	250 mg/l	75	56	39	35	39	48	69
SO <sub>4</sub> mg/l	250 mg/l	44	36	20	26	48	37	< 10
Fe mg/l	3 mg/l	8.7	15.7	1.6	.9	1.6	.3	5.9
Mn mg/l	.05 mg/l	1.0	1.2	7.7	2.9	.7	1.2	2.9
Na mg/l		143	64	41	130	50	41	176
P <sub>ol</sub> mg/l		0.018	.01	.008	.005	.001	.013	.001
Ast mg/l	*.05 mg/l + 5 mg/l	.005	.009	< .005	< .005	< .005		.031
Bat mg/l	*1 mg/l + 100 mg/l	.19	.29	.17	.16	.25		.33
Cdt mg/l	*.01 mg/l + 1 mg/l	.019	.01	.003	.006	.01		.001
Crt mg/l	*.05 mg/l + 5 mg/l	.018	.01	.014	.009	.01		
P mg/l	*.05 mg/l + 5 mg/l	.009	.02	.007	.005	.013		.017
Hgt mg/l	*.002 mg/l + .2 mg/l	.0005	.0001	.0002	.0001	.0005	.0002	.0002
Set mg/l	*.010 mg/l + 1 mg/l	.005	.005	.005	.005	.005		
Lgt mg/l	*.05 mg/l + 5 mg/l	.010	.01	.004	.005	.01		
Nitrate (N) mg/l	.10 mg/l	.3	.1	1.0	.1	.2		
F mg/l	*2.4 mg/l	.3	.3	1	1	1		
Endrin mg/l	*.0002 mg/l + .02 mg/l	.0003	.0002	.0002	.0002	.0002		
Lindane mg/l	*.004 mg/l + .4 mg/l	.0001	.0001	.004	.004	.004		
Methoxychlor mg/l	*.1 mg/l + 10 mg/l	.002	.003	.005	.001	.001		
Toxaphene mg/l	*.005 mg/l + .5 mg/l	.0001	.003	.005	.005	.005		
2,4-D mg/l	*.1 mg/l + 10 mg/l	.004	.01	.01	.10	.10		
2,4,5-Tp Silvex mg/l	*.01 mg/l + 1 mg/l	.004	.01	.01	.01	.01		

Based on Primary Drinking Water Standards. Transcribed K. Walborn 4/5/84

Chemical Division — NATION  
LABORATORY DEPT.

Well No GM-7

te Rec'd.: See Back

Sample: Water

DePT. ENV

Submitted By: C. Drum

Port To: C. Drum

DATE

ANALYSIS REQUIRED		GUIDE LIMITS	9/1/81	Nov 1981	MAR 1982	June 1982	Nov 1982	Apr 1983	Aug 1983
Radium 226	pCi/l	5. pCi/l	<.6	1.4	.6	.6	7		
Radium 228	pCi/l		<1	<1	<1	<1	<1		
Gross Alpha	pCi/l	*2. pCi/	<2	<2	<2	<2	<4		
Gross Beta	pCi/l	* dose4m-rem./yr.	<3	8±5	<3	<3	<5		
Turbidity	J.T.U.	*1. to 5	41	230	320	<100	260		
Coliform Bact. Colonies/100		*M.F. 4 colonies/100	640	2000	<20	<5	<5		
Hardness (as CaCO <sub>3</sub> )	mg/l		391	626	422	391	422	415	625
Alkalinity as HCO <sub>3</sub>	mg/l		477		515	477	515	506	763
Color	APHA	/15	5	5	0	0	30	0	0
TDS	mg/l	/500 mg/l	573	464	517	481	521	517	750
Ca	mg/l		92	152	124	110	119	136	99
Mg	mg/l	/1 mg/l	.033	.032	.026	.010	.03	.03	.02
	mg/l		6.4	4.9	1.6	.1	2.0	1.8	3.8
Fe	mg/l	/5 mg/l	.11	<1	.016	.065	.2	<.1	<.1
Mn	mg/l		15	30	25	23	23	26	24
	mg/l			<.01	.013	.006	.01	.01	.01

Based on Primary Drinking Water Standards. Transcribed K. Walkorn 4/5/84

A-4

Hydrogeologic Conditions at the PPG Industries, Inc., Plant Site,  
Natrium, West Virginia:

- Excerpt from Geraghty and Miller, Inc., Final Report, October 1982, containing pages 11-18, 22, 23, 25, 27-37, 38-45.
- None of the attached material is considered confidential by PPG.



copy 4 of 5  
Geraghty & Miller, Inc.

HYDROGEOLOGIC CONDITIONS AT THE  
PPG INDUSTRIES, INC., PLANT SITE  
NATRIUM, WEST VIRGINIA

FINAL REPORT

Prepared for  
PPG Industries, Inc.  
Natrium, West Virginia

October 1982

By  
Geraghty & Miller, Inc.  
Annapolis, Maryland

REGIONAL SETTING

Topography

Natrium is situated within the Ohio River Valley near the base of the West Virginia Northern Panhandle. This area is part of the Appalachian Plateau physiographic province and, in general, can be described as a highly dissected plateau or plain characterized by rugged topography, steep slopes, and strong relief, with elevations ranging from about 600 feet to more than 1600 feet above sea level. Stream erosion and transport, in conjunction with weathering and mass-wasting of slope materials, is largely responsible for the existing topographic expression of this region.

The Ohio River generally constitutes the feature of lowest elevation throughout the area and, thus, receives virtually all of the natural drainage via tributaries, surface runoff, overland flow, and groundwater discharge. Surface drainage patterns in the region can best be described as dendritic, where larger tributaries branch irregularly and angularly into smaller tributaries, resembling, in plan, the profile of a branching tree.

A notable exception to the rugged topography described above occurs in areas adjacent to the Ohio River and some

of its major tributaries where the deposition of flood plains and the carving of terraces into older and higher glaciofluvial outwash has created relatively level or gently inclined strips of land that tend to parallel the course of the river. These land features, which are commonly referred to as bottoms or bottomlands, are usually best developed on the inside of meanders (bends in a river) and fringe the Ohio River on alternate sides throughout its length. Owing to the flat-laying topography, the availability of water, and the close proximity to a major waterway, bottomlands along the Ohio have long been major centers of population and industry in the State.

#### Climate

Climate of the area is typical of temperate continental zones with warm summers and cold winters averaging 73°F and 34°F, respectively. The mean annual temperature for this area is about 53°F (Price, and others, 1956).

Precipitation is ample and fairly well distributed throughout the year with maximum and minimum rainfall occurring in summer and fall, respectively. Total annual precipitation in the Ohio Valley increases from north

to south. Normal precipitation for Wheeling is approximately 38 inches and for New Martinsville is about 44 inches. There are no available precipitation data for Natrium; it is assumed that average precipitation at the plant site ranges from 42 to 44 inches per year.

### Geology

The Northern Panhandle region is underlain by Paleozoic-age sedimentary rocks consisting mainly of conglomerates, sandstones, siltstones, shales, fresh-water and marine limestones, and coals, and lesser amounts of chert, iron ore, and rock salt or other evaporites. Coal deposits, which mainly occur in Pennsylvanian-age and, to a lesser extent, Permian-age rocks, have long been recognized as the greatest mineral resource of the Ohio River Valley area. Rock salt and natural brines of Silurian-age are of local importance to PPG and other chemical industries for the manufacture of chlorine, bleaches, soda ash, and caustic soda.

In hilly, more elevated areas of the Panhandle, rock units are generally overlain by a thin to moderately thick layer of sedentary or residual soil that has been formed in place by the distintegration of underlaying rocks, and

by the accumulation of organic material. These soils are usually relatively fertile and well drained and are capable of supporting woodland, cropland, and pasture. Owing to the hilly topography characterizing these areas, soils tend to be fairly susceptible to erosion.

In areas adjacent to the Ohio River, steep valley walls with outcropping rocks of Pennsylvanian- and Permian-age give way rather abruptly to bottomland alluvial deposits comprising flood-plain and river-terrace features. River terraces generally represent Pleistocene-age glacial outwash plains that have been carved into a stepped profile by the downcutting Ohio River. These features are mainly composed of sand and gravel and, in areas along the edges of the valley, may be capped by colluvium (clay and rock fragments) derived from highlands and valley walls. Lower river terraces may, in some cases, also represent abandoned flood plains constructed by the river during past, more elevated regimens. Such deposits probably contain significantly greater quantities of silt and clay than are found in terraces formed primarily from glacial outwash.

In the Natrium area, three main terrace levels are present with lower, middle, and upper terrace elevations

averaging 630, 660, and 690 feet above mean sea level, respectively. The upper terrace is bounded on the east by a steep valley wall that rises to an elevation of 1300 feet within one mile. The lower extent of the upper terrace is roughly delineated by West Virginia State Route 2, and the lower boundary of the middle terrace is similarly defined by the Baltimore and Ohio railroad. The lower-most terrace face is bounded by the Ohio River. These terraces, with the possible exception of the lower terrace, lie above the highest expected flood stage of the Ohio River; the Ohio River pool elevation in the Natrium area is about 620 to 624 feet above mean sea level and, as a result of downstream locks and dams, tends to remain fairly constant throughout high- and low-flow periods.

The higher river terraces are generally underlain by 90 to 110 feet of alluvium which lies unconformably upon bedrock of Paleozoic-age. The bedrock materials slope from the valley wall toward the Ohio River, probably reflecting the configuration of the river valley prior to aggradation by glacial outwash.

### Water Resources

The Ohio River represents the main body of surface water in the area and, with respect to volume, constitutes an almost unlimited supply. The quality of water from the Ohio River is suitable for many industrial uses; however, owing to the possible presence of undesirable chemical constituents resulting from upstream operations, river water would probably require some type of treatment before it would be acceptable for most domestic purposes. Table 1 summarizes the water quality of the Ohio River at Newell (north of Natrium) and Ravenswood (south of Natrium), West Virginia, and of Fishing Creek at New Martinsville (south of Natrium).

Groundwater constitutes a major source of water supply in the Natrium area. The most important water-bearing unit, the water-table aquifer, is comprised of the sand and gravel alluvial materials of the Ohio River valley. Yields from wells penetrating these sediments are reported to range from 100 to 500 gallons per minute (gpm), and natural water quality is generally good with total dissolved solids concentrations of 500 mg/l or less; locally, water may be hard and sulfurous (Price, and others, 1956). PPG is

Table 1. Quality of Surface Water in the Ohio River Valley Near Natrium, West Virginia (Doll, W. L., Meyer, G., and Archer, R. J., 1963)  
(All analyses are expressed in mg/l, except pH and specific conductance, which are expressed in standard units).

PARAMETER	Ohio River at Newell, W. Va. (1960 mean)	Ohio River at Ravenswood, W. Va. (1960 mean)	Fishing Creek New Martinsville, W. Va. (10/1/60)
Specific Conductance	360	413	304
Total Dissolved Solids	226	255	164
pH	-	-	7.4
Calcium	32	39	26
Sodium	19	24	21
Magnesium	9.2	9.6	6.1
Potassium	2.2	2.3	2.2
Total Iron	-	-	0.3
Manganese	-	-	0.28
Chloride	15	31	40
Bicarbonate	14	36	75
Sulfate	122	111	23
Nitrate	3.9	3.9	0.2
Fluoride	0.3	0.3	0.2
Silica	7.4	6.9	3.1
Total Hardness as CaCO <sub>3</sub>	225	245	118



presently pumping about five million gpd from wells constructed into this aquifer.

The Paleozoic bedrock units, which underlay the sand and gravel aquifer, are also capable of producing groundwater. Because well yields are generally low and water quality is often poor, these units have not been extensively developed as a groundwater supply in the Natrium area.

Table 2. Results of Grain-Size Distribution and Falling-Head Permeability (Kv) Analyses

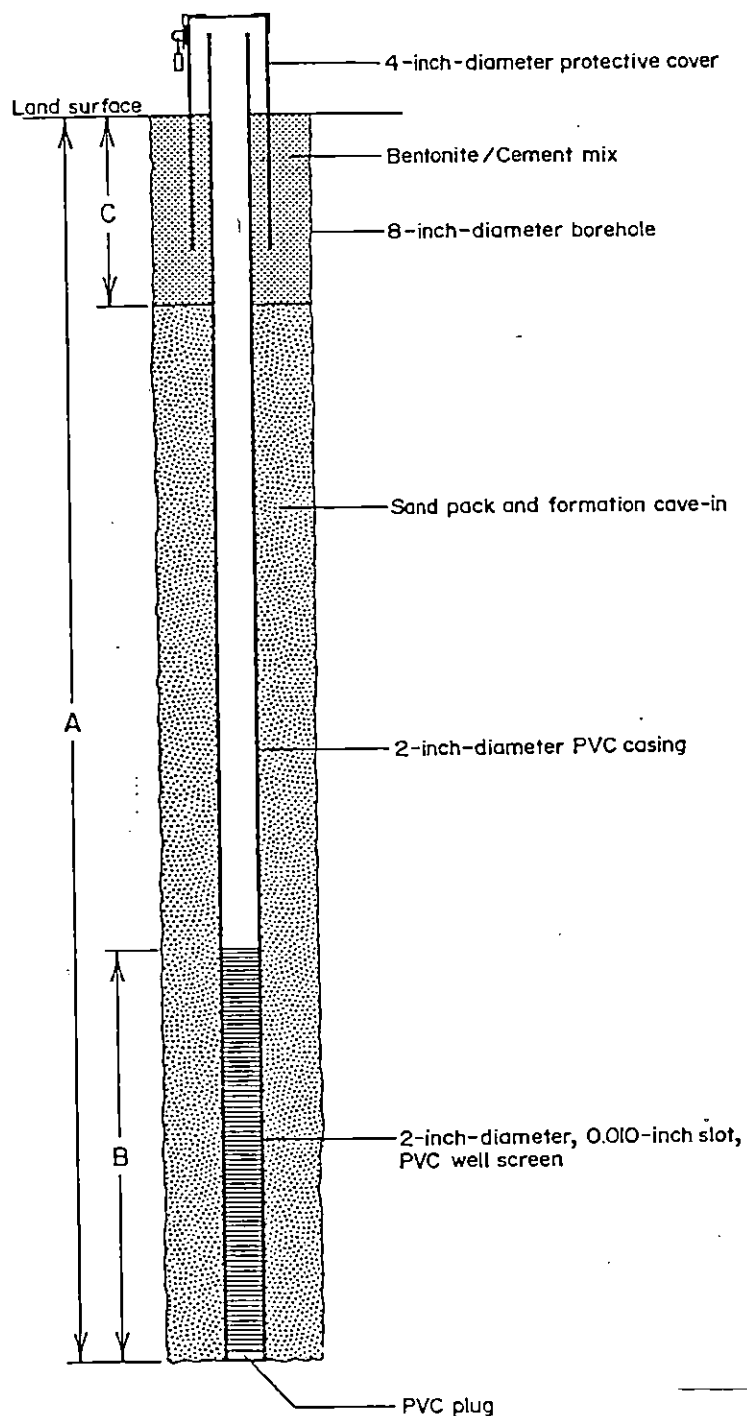
Well Number	Sampling Depth (ft)	Permeability (cm/sec)	Natural Moisture Content (%)	Gravel 2-76mm (%)	Sand 0.074-2mm (%)	Fines <0.074mm (%)	Type of Material
MW-5	30.0 - 31.5	NA	26.5	1	60	38	Silty clayey sand
MW-7	60.0 - 61.5	NA	16.7	4	94	2	Sand with trace of gravel
MW-12	75.0 - 76.5	NA	8.4	49	40	11	Silty sand and gravel
*MW-15	11.5 - 13.5	$3.4 \times 10^{-7}$	20.0	17	20	63	Sandy silty clay
*MW-16	22.5 - 24.5	$2.2 \times 10^{-6}$	20.6	14	12	74	Sandy clayey silt

\*Shelby tube sample

NA - Not Analyzed

Table 3. Results of Cation-Exchange Analyses

Well Number	Sampling Depth (ft)	Type of Material	Cation Exchange Capacity (meq/100g)
MW-9	10.0 - 11.5	Clay with pebbles	5
MW-9	60.0 - 61.5	Sand with a few pebbles	4
MW-15	20.0 - 21.5	Silty clay	4
MW-15	50.0 - 51.5	Sand with pebbles	6
MW-18	15.0 - 16.5	Silty clay	7
MW-18	40.0 - 41.5	Sand with pebbles	3



MONITOR WELL NUMBER	DIMENSIONS, IN FEET		
	A	B	C
MW-1	52.5	10.0	15.0
MW-2	97.0	30.0	21.0
MW-3	50.0	30.0	6.0
MW-4	56.0	40.0	5.0
MW-5	40.5	32.0	6.0
MW-6	74.0	40.0	8.0
MW-7	83.0	40.0	17.0
MW-8	83.0	40.0	3.5
MW-9	82.5	40.0	20.0
MW-10	90.0	30.0	20.0
MW-11	90.0	30.0	17.0
MW-12	88.0	30.0	3.0
MW-13	84.0	30.0	20.0
MW-14	67.5	37.0	18.0
MW-15	69.5	40.0	10.0
MW-16	64.0	43.0	10.0
MW-17	66.0	40.0	14.0
MW-18	64.5	40.0	10.0
MW-19	89.0	40.0	12.0

Figure 4. Typical Monitor-Well Construction, PPG, Natrium, West Virginia

Aquifer-Testing Program

On September 28 and 29, 1981, an aquifer-testing program consisting of recovery and drawdown monitoring was conducted in the northwest corner of the main plant site. This program, which was aimed at better defining the hydraulic properties of aquifer materials, utilized process well 28 as a controlled pumping center and observation wells 28-AM, 28-BM, MW-7, and MW-8 as potentiometers for monitoring changes in water-level elevation (see Figure 5 for approximate well locations).

For at least three days prior to the test, well 28 was continuously pumped at a rate ranging from 365 to 425 gpm. After taking preliminary water-level measurements in the four observation wells to verify that groundwater levels were not fluctuating, pumping of well 28 was discontinued. The level of water in wells began to rise and the rate of this recovery was measured periodically in the four observation wells for the next 21 hours. Due to time allotments for the test, it was not possible to allow water levels to reach a non-fluctuating condition; however, when the recovery test was stopped, water levels were rising at a very slow rate. Pumping of well 28 was then resumed at an average rate of 390 gpm, and water-level drawdown was

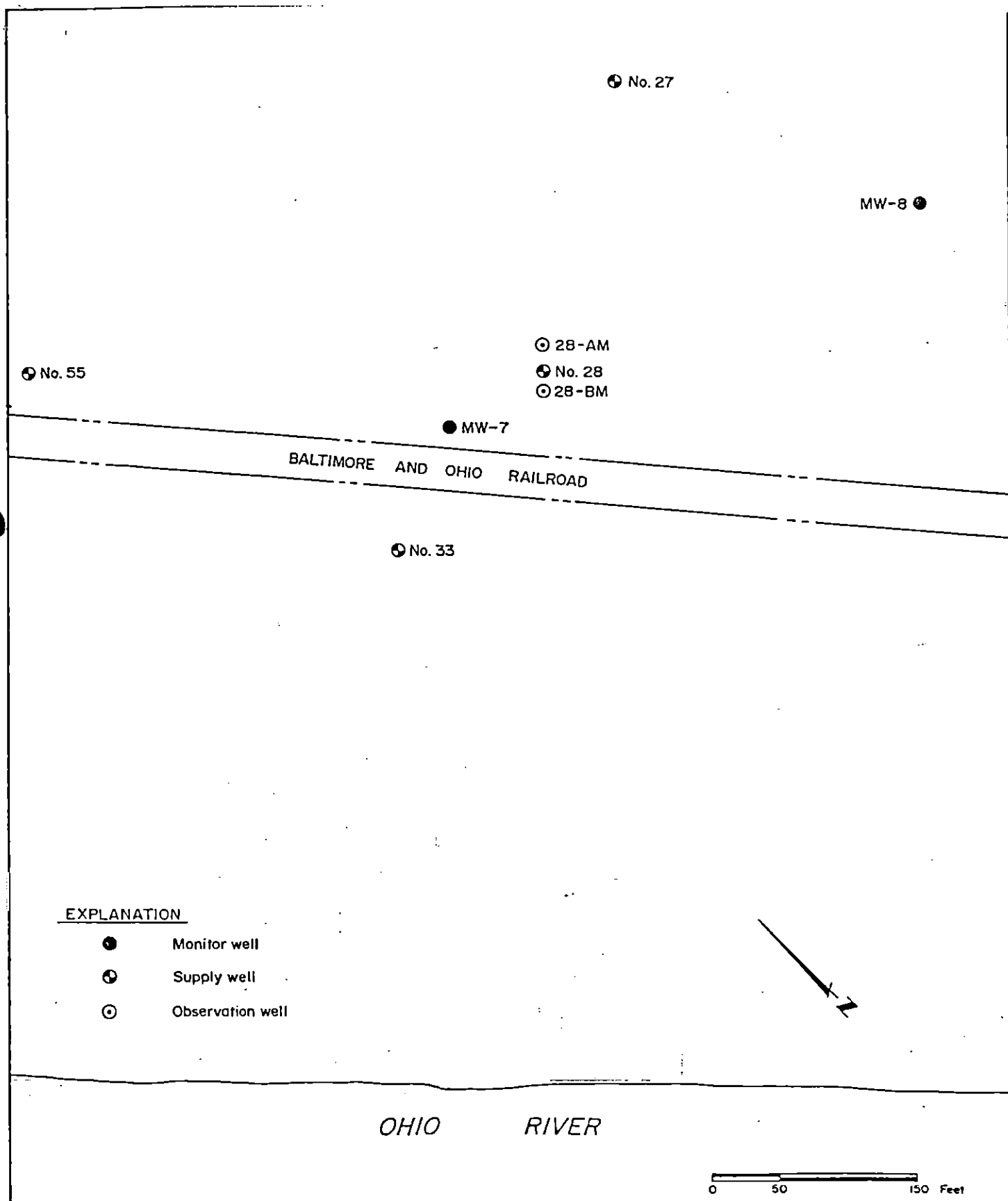


Figure 5. Well Locations in the Aquifer-Testing Area at PPG, Natrium, West Virginia

measured in the observation wells over the next seven hours. At the end of seven hours, the water level in the 28-BM observation well was still dropping slightly, but levels in the other three observation wells appeared to be relatively stable.

It should be noted that prior to and throughout the aquifer-testing program, PPG supply wells 27, 33, and 55 were in continuous operation; these wells are situated in relatively close proximity to well 28 (see Figure 5) and may have affected water levels in the observation wells. This situation may have caused some anomalies in drawdown and recovery data, particularly if the pumping rates of nearby wells fluctuated significantly during the testing period.

Recovery and drawdown data for observation wells 28-AM and 28-BM were graphically plotted as time versus recovery and time versus drawdown relationships, and the Jacobs method was used to calculate values of transmissivity (T) and storage coefficient (S) (Johnson Division, 1975). Data from observation wells MW-7 and MW-8 were not extensively evaluated due to a lack of sufficient water-level response during pumping and recovery. Recovery

and drawdown data for the four observation wells are presented in Appendix F.

The calculated transmissivity (T) of the aquifer, based on recovery and drawdown data from the 28-BM well, was fairly consistent at 80,400 gpd/ft and 93,600 gpd/ft, respectively (see Figure 6); assuming a saturated aquifer thickness (m) of about 40 feet, these values correspond to a hydraulic conductivity (K) of roughly 2175 gpd/ft<sup>2</sup> (10<sup>-1</sup> cm/sec). The storage coefficient (S) determined from calculated T values is unrealistically high, 0.98 and 1.23, respectively; typical S values for water-table aquifers range from 0.01 to 0.35. The high calculated S value probably reflects aquifer recharge by the Ohio River.

Aquifer transmissivity (T) as determined from recovery and drawdown data in the 28-AM well varied substantially at 111,735 gpd/ft and 27,934 gpd/ft, respectively. Owing to the difference in calculated T value and uncertainties as to what factors may have caused this variation, data obtained from the 28-AM well are not considered valid will not be discussed further.

It should be noted that in April 1962, Rawe Drilling Company also conducted an aquifer test using well 28 and



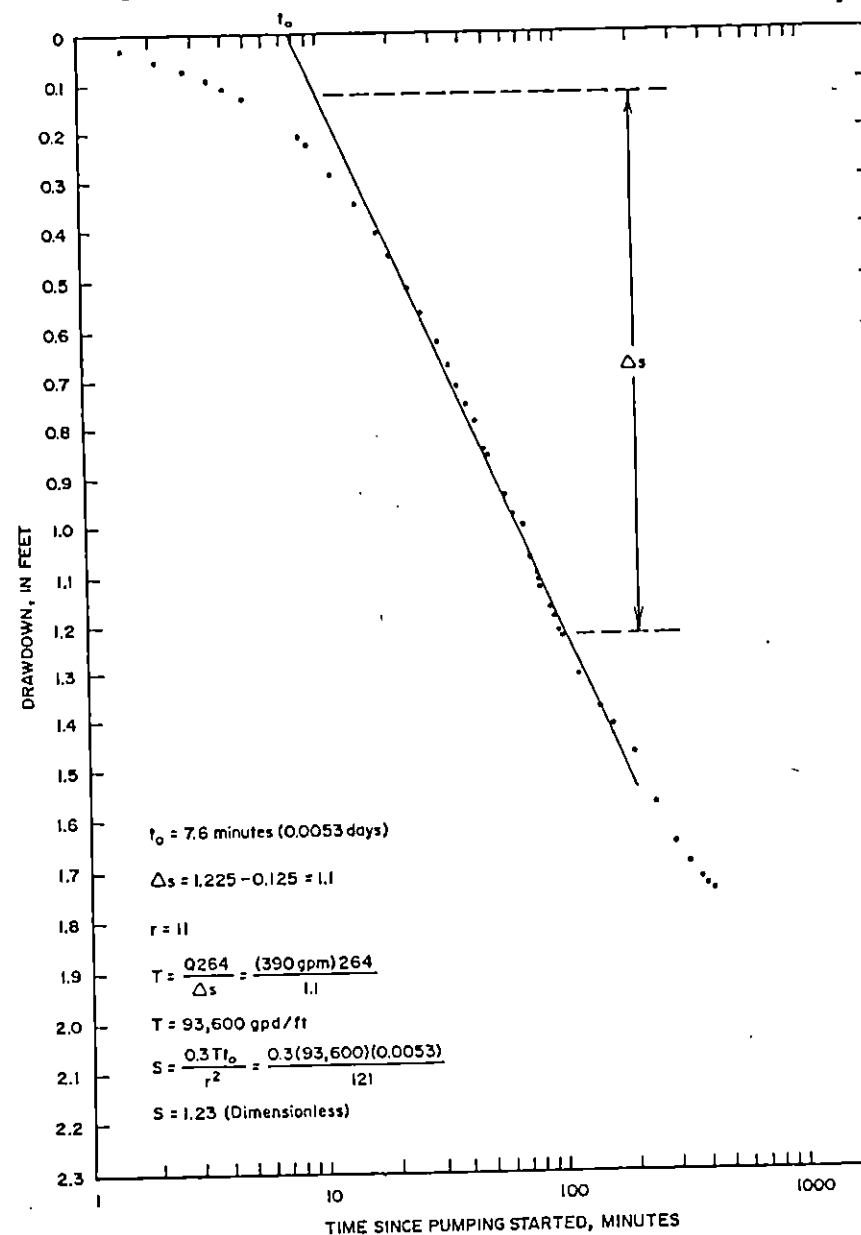
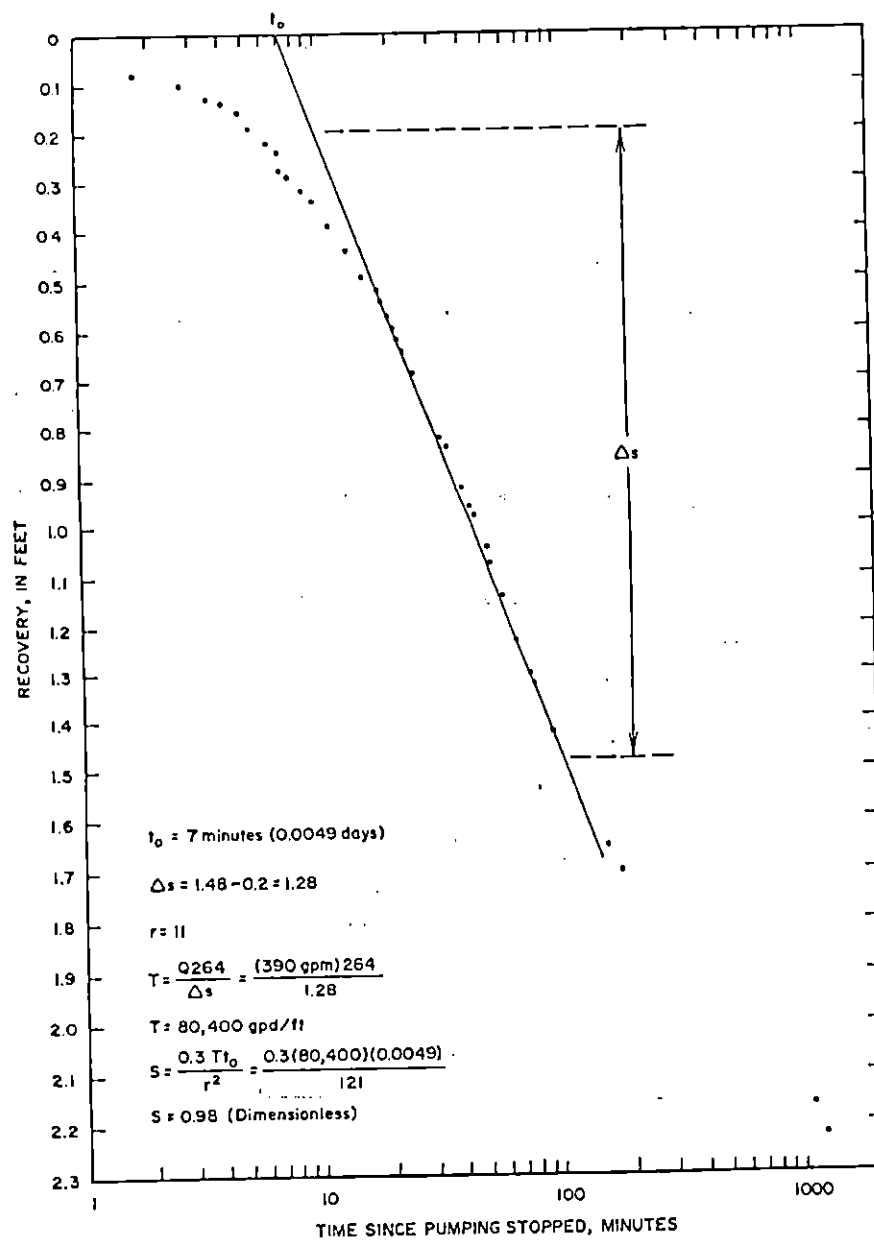


Figure 6. Graphical Representation of Recovery and Drawdown Data, 28-BM Location, PPG, Natrium, West Virginia

observation wells 28-AM and 28-BM. The reported transmissivity from this test was 539,000 gpd/ft. Inconsistencies in the reported data, and the fact that T values of this magnitude are not typical for the type of materials comprising this aquifer, make the results reported by Rawe somewhat suspect.

## SITE HYDROGEOLOGIC CONDITIONS

### Geology

The plant site is underlain by unconsolidated deposits of sand, silty to sandy clay, and pebbles, which lie unconformably upon a bedrock base. Results of grain size analyses presented in Table 2 indicate the gross physical composition of soil samples selected to represent unconsolidated deposits.

Throughout central portions of the plant, roughly parallel to Skyline Drive, sediments consist predominantly of sand and pebbles which extend downward 90 feet or more to bedrock. In the east and west (upper and lower) plant areas, sand is generally overlain by beds of silty to sandy clay which tend to thicken toward the Ohio River and the valley wall (see Figures 7 through 10).

The coarser soil materials (i.e., sand and gravel) are composed primarily of quartz and lesser amounts of feldspar minerals, as determined by visual inspection. No laboratory tests were conducted to determine the exact mineralogy of clays and finer soil fractions; however, the low cation exchange capacities (7 meq/100 g or less) determined for clay-rich samples suggest that kaolinite  $[Al_4(Si_4O_{10})(OH)_8]$

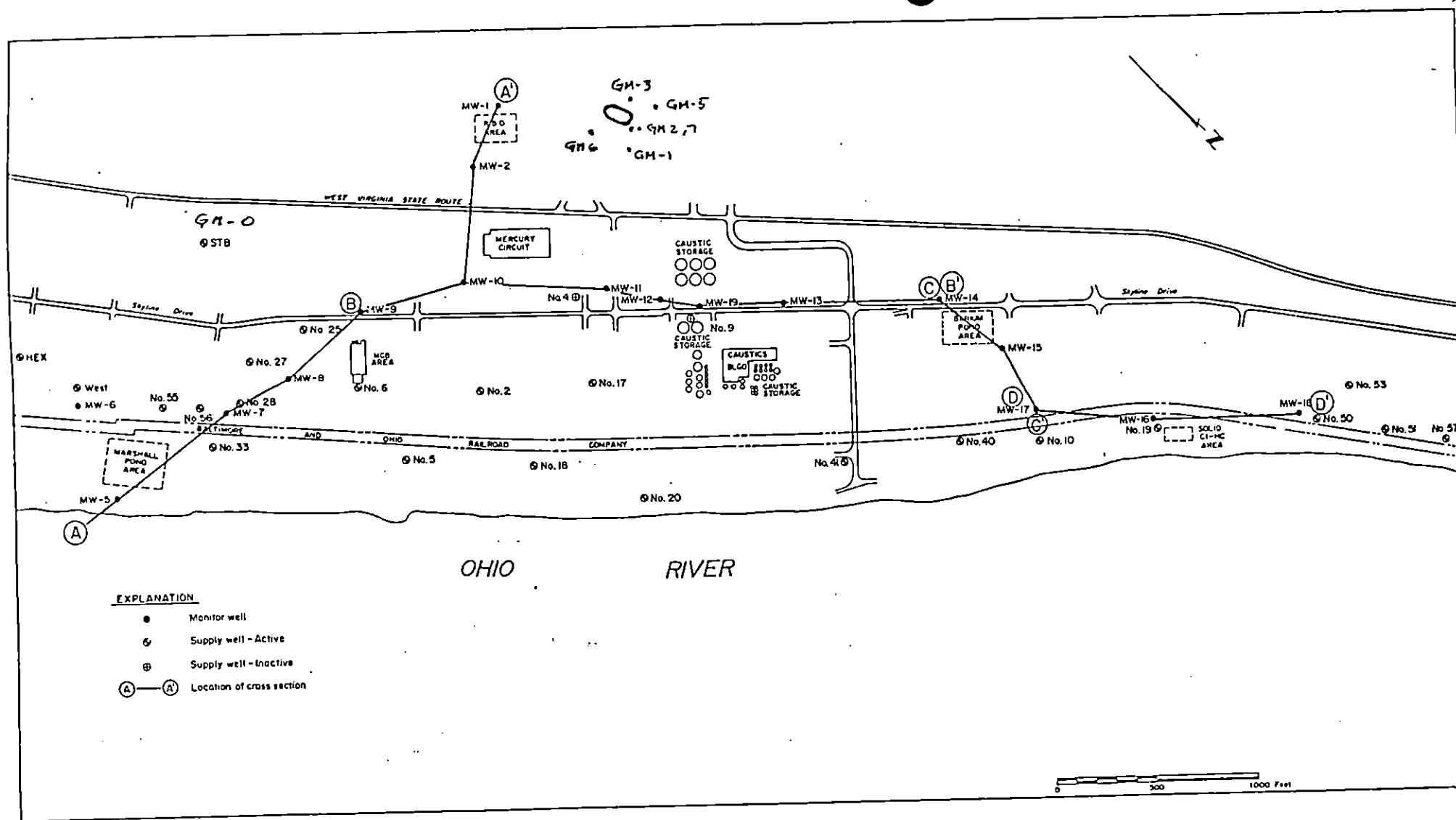


Figure 7. Geologic Cross-Section Reference Map, PPG, Natrium, West Virginia

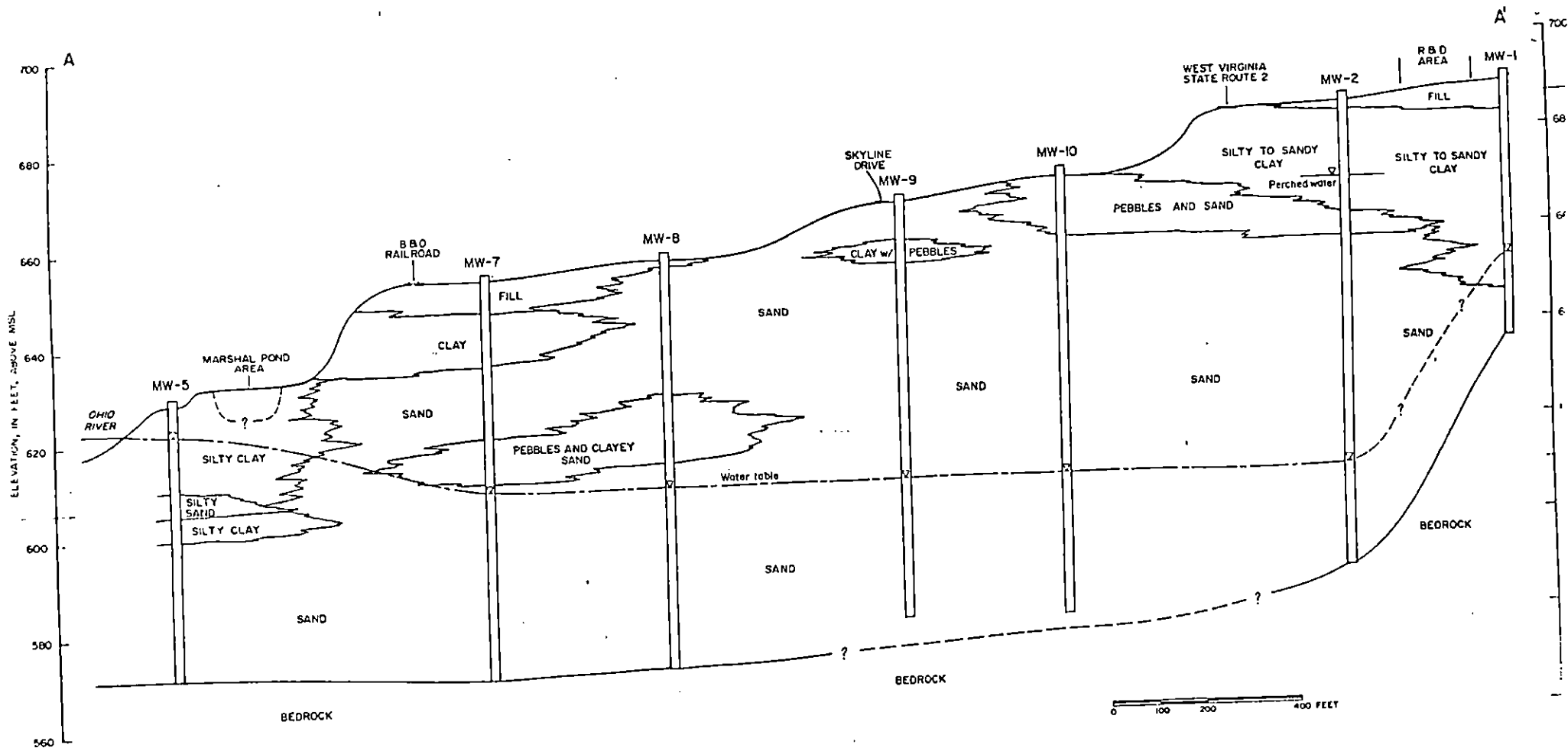


Figure 8. Geologic Cross-Section A-A', PPG, Natrium, West Virginia

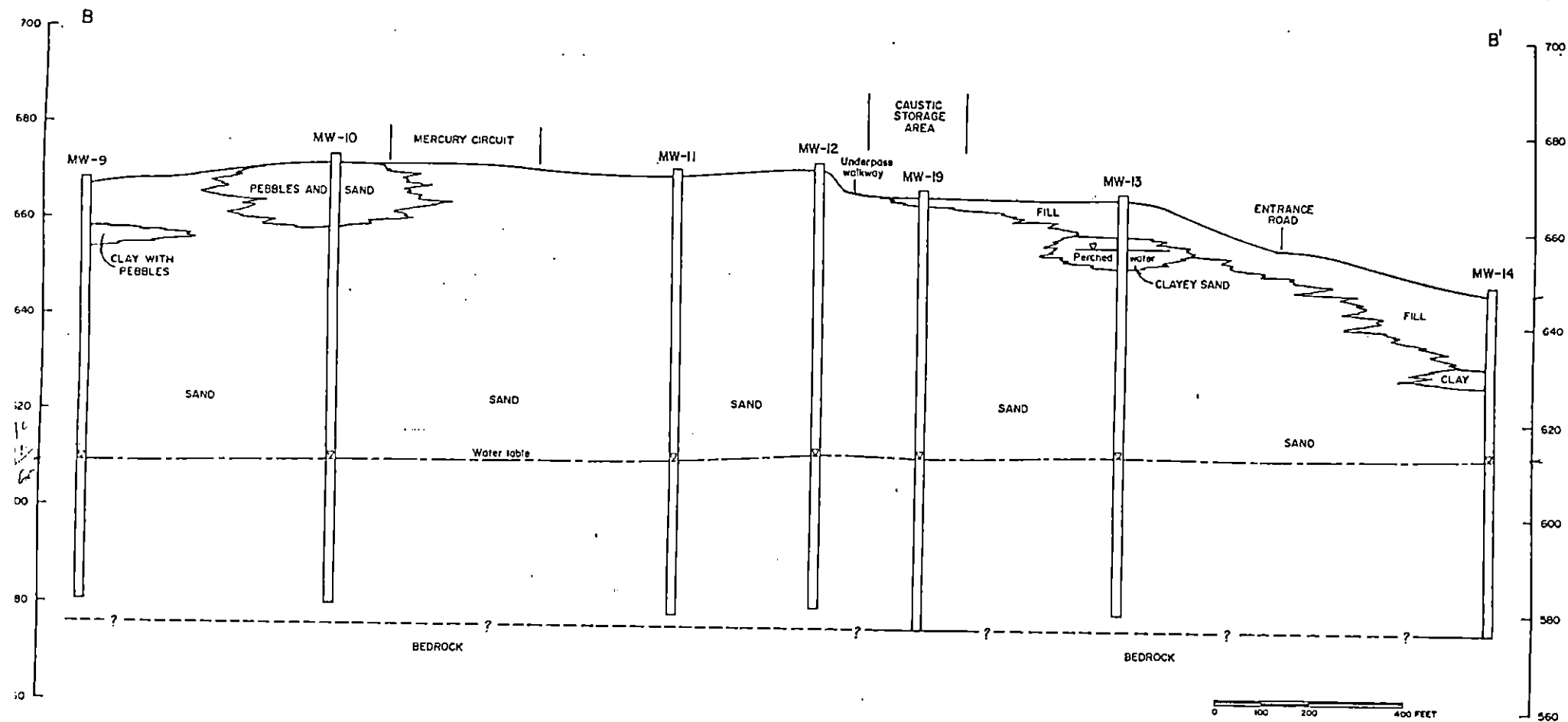


Figure 9. Geologic Cross-Section B-B', PPG, Natrium, West Virginia

may be a primary component (Garrels and Christ, 1965). Results of cation exchange analyses are presented in Table 3.

As noted in the preceding section, most of the sand and gravel materials comprising Wells Bottom are thought to represent outwash that aggraded the Ohio River Valley during retreat of Pleistocene glaciers. Accumulations of finer sediments, particularly in areas adjacent to the Ohio River, may also represent deposition of floodplain alluvium during more elevated river regimens. Silty to sandy clay deposits underlaying upper plant areas probably, for the most part, represent locally deposited colluvium and detrital materials derived from weathering and mass-wasting of uplands and valley walls; rock fragments are common throughout these sediments.

#### Aquifer Characteristics and Groundwater Flow

Two types of water-bearing zones are present at the plant site: 1) discontinuous zones of perched groundwater, and 2) the Ohio River Valley water-table aquifer. Perched zones represent unconfined groundwater that is separated from the water table by an unsaturated zone. When present, perched zones were generally situated within silty to sandy

clay materials which, due to their relatively low permeability (Table 2), restrict the downward percolation of recharge waters. The locations and depths of observed perched-water zones are indicated in Table 4 and on Figures 8 through 10.

The Ohio River Valley water-table aquifer is comprised primarily of sand and gravel, and constitutes the main water-bearing unit in the area. The aquifer has been extensively developed within the plant site and is presently yielding about five million gallons of water daily, most of which is being pumped from two main PPG well fields located in the northwest and southwest corners of the main plant (Figure 2).

Data obtained from the aquifer-testing program indicate that aquifer sediments typical of the central plant area are characterized by a transmissivity (T) probably ranging from 80,000 to 95,000 gpd/ft (see Figure 6). Based on an average saturated aquifer thickness of about 40 feet, this T corresponds to a hydraulic conductivity of about  $10^{-1}$  cm/sec or greater.

No aquifer tests were conducted in areas of the plant along the Ohio River. However, in borings immediately



Table 4. Perched-Groundwater Zones Encountered During Drilling

Boring Number	*Depth to Perched Zone (ft below land surface)	*Elevation of Perched Zone (ft above MSL)	*Height of Perched Zone Above Water Table (ft)	Description of Sediments Containing the Perched Zone
MW-2	15.5	670	60	Silty to sandy clay with pebbles
MW-13	10.0	656	44	Clayey sand
MW-15	11.5	633	21	Silty to sandy clay
MW-18	5.0	635	22	Silty clay

\*All depths and elevations are approximate

adjacent to the river (e.g., MW-4 and MW-5), the sand deposits appeared to be slightly more fine grained and more silty than in central plant areas, and are probably characterized by a somewhat lower hydraulic conductivity.

Prior to development of the aquifer, the water table probably sloped from east to west with groundwater flowing toward and discharging into the Ohio River; the exact configuration of the water table and the depth to water are not known, however. Pumping of wells has caused the water table to drop below the level of the river. As a result, water is now being pulled from the river into the aquifer, and is flowing in the direction of pumping centers (see Figure 11 and Table 5). Therefore, under present pumping conditions, the water-table aquifer is receiving recharge from both infiltrating precipitation and the Ohio River. Assuming an average annual precipitation of 43 inches and an infiltration of 20 to 50 percent of total precipitation, estimated infiltration ranges from 400,000 to 1,000,000 gallons per day per square mile. The area of land receiving infiltration-recharge that may eventually reach PPG's wells is probably less than two square miles; therefore, about two mgd or less of PPG's groundwater consumption is recharged by precipitation. Consequently, the Ohio River must be

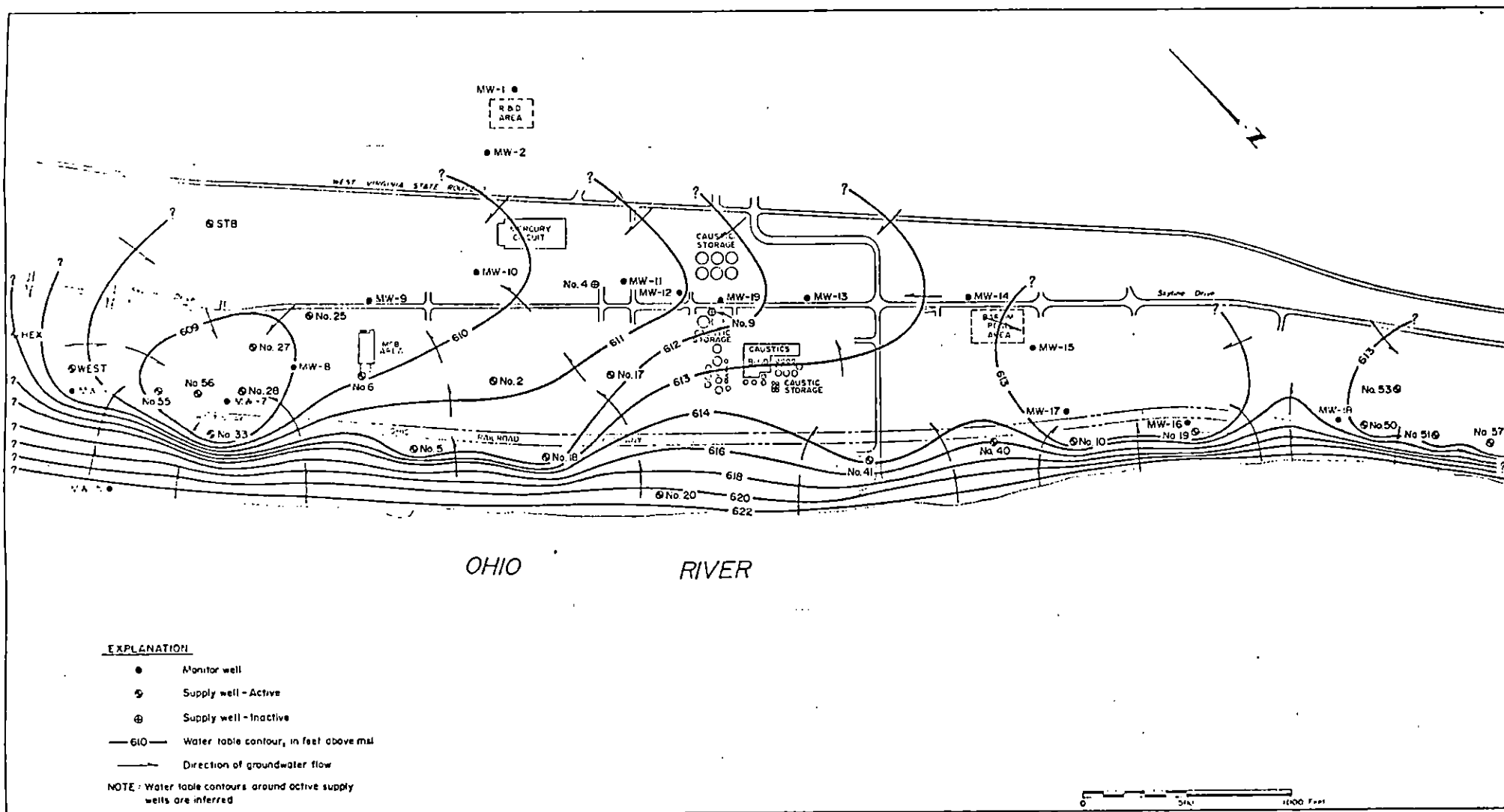


Figure 11. Water-Table Contour Map and Groundwater Flow Patterns at PPG, Natrium, West Virginia (Based on 09-28-81 Monitor Well Water Level Data)

Table 5. Water Level Data for Monitor Wells  
 MW-1 through MW-19 and the Ohio River  
 (measurements taken 09-28-81)

Monitoring Point	Elevation at Top of PVC Casing (ft. above MSL)	Depth to Water Below Top of PVC (ft.)	Elevation of Water Table (ft. above MSL)
MW-1	690.99	36.19	654.80
MW-2	687.44	77.17	610.27
MW-3	640.30	19.92	620.38
MW-4	637.16	17.53	619.63
MW-5	629.57	7.43	622.14
MW-6	646.89	36.16	610.73
MW-7	654.58	45.91	608.67
MW-8	657.86	48.85	609.01
MW-9	668.46	58.97	609.49
MW-10	673.59	63.71	609.85
MW-11	671.56	61.12	610.44
MW-12	673.02	62.08	610.94
MW-13	667.56	55.28	612.28
MW-14	649.10	36.00	613.10
MW-15	646.01	33.75	612.26
MW-16	640.18	27.75	612.43
MW-17	641.85	29.66	612.19
MW-18	641.87	28.36	613.51
MW-19	667.92	56.36	611.56
Ohio River	NA	NA	app. 624

NA - Not applicable

supplying at least 60 percent or more of the groundwater consumed by PPG; otherwise, the aquifer could not sustain the five mgd that is presently being withdrawn.

Aquifer recharge from the Ohio River is reflected by the steep hydraulic gradient along the plant/river boundary. Based on the groundwater flow patterns indicated on the water-table contour map (Figure 11), there is no apparent natural discharge of groundwater to surface-water bodies in the vicinity of PPG's main plant.

Observed fluctuations in the temperature of groundwater samples collected from supply wells may be a further indication of inflow from the Ohio River. In aquifers receiving recharge mainly from precipitation, groundwater temperatures tend to remain fairly constant throughout the year, and are generally about the same as the average annual air temperature. However, at the PPG site, samples collected over the past two years from many of the supply wells have exhibited inconsistencies in temperature (for a given well). The most plausible explanation is that surface water, which does experience a significant degree of seasonal variation in temperature, is being pulled into the water-table aquifer.

In addition to the water-table aquifer, the plant site is also underlain by a bedrock aquifer system at a depth of about 160 feet. In the mid-to-late-1950s, PPG installed several wells into this aquifer to determine its potential as a drinking water source. However, well yields were low (3 to 15 gpm), and natural groundwater quality was undesirable due to high TDS concentrations (Charles Drum, personal communication, 1981). Consequently, the wells were taken out of service and PPG has made no further attempts to develop the bedrock aquifer.

PROPOSED WELL INSTALLATION AND SAMPLING AND ANALYSIS PLAN FOR THE  
PPG MERCURY POND

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- 2.0 Well Installation and Sampling and Analysis Plan
  - 2.1 Introduction
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- 3.0 Summary
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## 1.0 BACKGROUND INFORMATION

The surface impoundment at PPG's Natrium, West Virginia, plant site was initially used (from 1943 until about 1960) as a storage basin for sodium chloride brine produced from deep wells tapping Silurian-age deposits. During this period, the impoundment was concrete lined. After more than a decade of retirement, the facility was refurbished and equipped with a low-permeability synthetic liner, and has been used since 1970 to contain waste flow from the plant's mercury cell, chlorine circuit. Fluids currently entering the pond have a brine-type composition, and are characterized by a high pH (11.5 to 12.0) and appreciable concentrations of dissolved mercury (350 micro-gram/liter range). The mixed mercury waste within the pond is precipitated as mercury sulfide and the resultant clarified liquid is treated via carbon filtration prior to discharge into the Ohio River. The Mercury Pond is periodically cleaned and the liner has been replaced once.

The Mercury Pond facility is situated upon naturally high ground located immediately adjacent to the east valley wall of the Ohio River. Beneath this area, the alluvial aquifer (the uppermost water-bearing unit) abruptly pinches out (or becomes very thin) against the steeply rising bedrock deposits of the valley wall. Owing to these conditions, the monitor-well boring installed topographically upgradient from the Mercury Pond (GM-3) failed to intercept the uppermost aquifer; i.e., bedrock was encountered at an elevation higher than the water table. This necessitated the use of an alternative sampling location (GM-0) to characterize background-water quality at the Natrium site.

The GM-0 (or STB) well, also referred to as the "reference" well, is a plant pumping well and is located roughly two thousand feet west of the Mercury Pond, toward the Ohio River. In selecting this well to represent background-water quality, several important criteria had to be met. The well had to be situated so as not to intercept groundwater emanating from beneath the Mercury Pond and water produced from the well should represent natural aquifer fluids, and not induced recharge from the Ohio River. Unfortunately, site geologic conditions did not permit compliance with another important criterion;

namely, the background well and the three downgradient monitor wells (GM-1, GM-2, and GM-6) should be installed into deposits of similar lithology. Downgradient wells are installed through predominantly silt- and clay-rich materials largely derived from weathering and mass-wasting of the valley wall (rock fragments are common); whereas, deposits beneath the GM-0 location are probably comprised mainly of clean sand and gravel representing glacial outwash (geology beneath the GM-0 location is inferred by nearby wells for which logs are available).

Results of the groundwater monitoring program conducted under 40 CFR 265 Subpart F (detection monitoring) indicate a statistically significant difference in water quality between the background and the downgradient wells; specifically, downgradient Wells GM-1, GM-2, and GM-6 contain higher concentrations of TOC and are characterized by higher specific conductivities than were observed in the GM-0 background well. However, supplemental water-quality data generated throughout the course of 1982 detection monitoring (Table 1), and recent data generated as a result of this water-quality assessment program (Table 2), suggest that:

- 1) Higher-than-background TOC levels in downgradient monitor wells are *wrong* probably reflective of differences in lithology between the background and the downgradient monitoring areas, and
- 2) Significantly higher SC levels in downgradient wells are probably *Possibly* related to seepage that occurred several decades ago, when the pond existed as a cement-lined brine storage facility.

The specific rationale behind these interpretations are discussed in more detail within the following sections.

#### TOTAL ORGANIC CARBON ANALYSES

Total Organic Carbon (TOC) values in groundwater can reflect natural, as well as artificially induced, sources of organic carbon. In uncontaminated groundwaters, natural TOC levels typically range from <5 to 10 or more milligrams per liter (mg/l), but values of several times these amounts are not uncommon in systems containing relatively abundant quantities of organic matter (e.g., peat).

In general, clays and other fine grained sediments normally tend to contain a greater proportion of organic matter than is usually present in sands and coarse grained deposits. This trend, in part, probably reflects differences in energies of depositional environments. In relatively low-energy, clay-depositing environments, sediments generally experience lesser degrees of winnowing and reworking than occur in relatively high energy, sand-and gravel-depositing environments. Also, organic matter may be less readily decomposed in clay and silt deposits than in sands, because of reduced aeration (and oxidation) within fine-grained sediments.

Average TOC values determined during 1982 detection monitoring of downgradient monitor wells GM-1, GM-2, and GM-6, were 17, 7 and 10 mg/l, respectively, as opposed to an average of about 3 mg/l in the GM-0 background well (Table 1). In data from the recent water-quality assessment program (Table 2), average TOC values were 8.6, 4.4, and 6.5 mg/l in the three downgradient wells and 1.3 mg/l in the background well; the average TOC level for Mercury Pond fluids was about 4 mg/l. All of the recorded TOC values are thought to be within a natural range.

Based on the analytical results presented in Table 2, the Mercury Pond does not appear to represent a likely source for higher-than-background TOC levels in downgradient wells, because fluids contained in this impoundment are characterized by appreciably lower TOC values than are typically found in groundwater sampled hydraulically downgradient from the Mercury Pond facility. Because PPG has not stored or disposed of any synthetic organic compounds in the Mercury Pond area (as evidenced by low TOX values in Table 1 as well as the organic analysis presented in Table 3), it is reasonable to hypothesize that differences in TOC levels between the background and the downgradient wells reflect natural variations in groundwater quality that result from differences in lithology; i.e., downgradient wells are installed into clay- and silt-rich deposits whereas the background well is constructed in predominantly sand and gravel deposits. Also, downgradient monitor wells are located in relatively close proximity to valley wall bedrock deposits and associated layers of coal, a concentrated TOC source material and coal fragments were noted in several of the lithologic logs prepared from downgradient well borings.

Based on these findings, TOC and TOX are not likely to be viable parameters for the detection of leakage.



## SPECIFIC CONDUCTANCE ANALYSES

Specific conductance (SC) is a measure of the ability of a fluid to conduct an electrical current (expressed in micro-mhos per centimeter), and is an indication of the ion concentration in a solution; as the ion concentration increases SC also increases. Inspection of averaged 1982 monitoring data presented in Table 1 indicates that significantly higher SC levels in downgradient monitor wells primarily result from higher-than background levels of sodium, and to a lesser extent, chloride, magnesium, and iron. Bicarbonate also appears to be elevated in downgradient wells; however, this ion is less closely related to SC (Hem, 1970), and it is uncertain how bicarbonate may influence observed SC trends.

Natural sources of sodium in groundwater include sodium-bearing minerals like plagioclase feldspar and halite (which also represents a main chloride source). However, sodium levels in downgradient wells are more than an order-of-magnitude higher than found in the GM-0 background well, and it seems unlikely that a difference of this magnitude can be totally attributed to natural variations in groundwater quality between the background and downgradient monitoring areas.

Comparisons of analytical data presented in Table 2 also tend to rule out the Mercury Pond as a probable source for relatively high sodium and chloride levels in downgradient wells. If the Mercury Pond had been losing fluids to the underlying aquifer system, particularly in an area where the aquifer is not very extensive, it is expected that groundwater receiving this seepage would begin to acquire quality traits reflective of the composition of the effluent. As can be seen in Table 2, groundwater obtained from downgradient monitor wells has a vastly different chemical makeup from that found in Mercury Pond fluids. In particular:

- Downgradient monitor wells exhibit a near-neutral pH (7.0 to 7.3); *True*  
whereas, fluids in the Mercury Pond have a very high pH (11.6 to 12.0)
- Dissolved mercury is present at appreciable levels in pond fluids  
(about 350 ug/l), but is essentially absent in downgradient monitor wells *True*

- Mercury Pond brine contains high concentrations of sodium and chloride with Na/Cl ratios ranging from 0.72 to 0.76 (typical of a NaCl source); whereas, groundwater in downgradient wells has substantially greater proportions of sodium relative to chloride, with Na/Cl ratios ranging from 1.6 to 6.8

The latter observation is especially important in discounting the Mercury Pond as a probable cause of water-quality differences in downgradient wells. Because natural source materials for sodium and chloride are not believed to be abundant in the alluvial aquifer system, it is reasonable to expect that Na/Cl ratios in groundwater receiving brine-type effluents would gradually become similar to that of the brine, even though ion concentrations may be substantially lower; i.e., brine effluent entering the system would probably have a significant enough contribution to the overall sodium and chloride levels that it would tend to control Na/Cl ratios.

The above reasoning would also rule out past brine storage practices (i.e., 1943 until about 1960) as a likely source of relatively high sodium and chloride levels in downgradient wells. However, it is important to keep in mind that seepage from the old facility would have been eliminated more than 20 years ago (when the facility was initially closed) and it is possible that natural mechanisms operating within the subsurface system have acted to change the relative proportions of sodium and chloride ions that were introduced via brine seepage.

One possible explanation for how such a change might occur relates to differences in the retardation factors for chloride and sodium. The chloride ion, owing to its small size and negative charge, behaves very conservatively within the groundwater system, i.e., it is not readily removed from solution via sorption or precipitation, and is potentially very mobile (relative to other ions). Sodium is also fairly conservative, compared to other cations, but is considerably more subject to attenuation than the chloride ion. This is largely because sodium is adsorbed onto mineral surfaces having appreciable cation exchange capacities (e.g., clays) (Hem, 1970), especially at high concentrations where the sodium ion may tend to replace other adsorbed cations (e.g., calcium and magnesium). Consequently, it is reasonable to assume that a clay-rich system receiving brine effluents would tend to preferentially retain

sodium, relative to chloride. It also follows that, once the source of effluent is eliminated, chloride ions should be flushed from the system more readily than the adsorbed sodium ions.

A related, possible explanation for why sodium is now back into solution (i.e., a dissolved groundwater constituent) at higher-than-background levels is that dissolved sodium ions, having been preferentially adsorbed onto clays when introduced at high levels (i.e., during brine seepage), have dropped in concentration (due to source elimination) to a point where adsorbed sodium is now being replaced by more strongly attracted cations. This condition is roughly analogous to the operation of a water softener, where the adsorbing medium, having been flushed with a high sodium solution to replace calcium and other cations, begins to release sodium as hardness-contributing parameters are adsorbed back onto the medium.

Because of the persistent presence of past salt contamination, monitoring for sodium, chlorides or specific conductivity will likely result in false positives and consequently these are not valid parameters for monitoring the mercury impoundment.

TABLE 1.  
AVERAGED RESULTS OF WATER-QUALITY ANALYSES CONDUCTED DURING 1982 DETECTION MONITORING  
AT THE PPG MERCURY POND  
(averages represent mean of 1/4/82, 5/10/82, 8/3/82, and 11/15/82 water-quality data;  
all values are expressed in mg/l unless otherwise specified)

Well Number	pH (Std. units)	SC (umhos/cm)	TOC	TOX (ug/l)	TDS	Total ALK. (as CaCO <sub>3</sub> )	HCO <sub>3</sub>	Cl	SO <sub>4</sub>	Na	K	Ca	Mg	Fe	Mn	Hg (ug/l)	Na/Cl
G1-0	7.1	618	3	49	399	287	350	21*	80	11	2	108	11	0.1	<0.01	<0.2	0.5
G1-1	7.2	995 ↑	17 ↑	77 ↑	619 ↑	506 ↑	617 ↑	25 ↓	4 ↓	136 ↑	2	116 ↑	32 ↑	29 ↑	1.5	<0.5	7.5 ↑
G1-2	7.1	1249 ↑	7 ↓	48 ↑	779 ↑	504 ↑	615 ↑	69 ↑	9	245 ↑	5	107 ↑	25 ↑	11 ↑	2.7	<0.5	3.9 ↑
G1-6	7.2	896 ↑	10 ↓	26 ↑	585 ↑	259 ↑	317 ↑	68 ↑	123 ↓	130	5	103	15	6	2.1	0.4	2.1

\*Median value used because of anomalously high result in 1/4/82 analysis.

SO<sub>4</sub> K Ca Mg Fe Mn Hg Na/Cl

TABLE 2.  
RESULTS OF CHEMICAL ANALYSES CONDUCTED DURING THE PHASE I WATER-QUALITY ASSESSMENT  
AT THE PPG MERCURY POND  
(all values are expressed in mg/l unless otherwise specified)

Well Location	pH (std. units)	SC (micro/cm)	TOC	TDS	Total ALK. (as CaCO <sub>3</sub> )	HCO <sub>3</sub>	Cl	SO <sub>4</sub>	Na	K	Ca	Mg	Fe	Mn	SiO <sub>2</sub>	Hg (ug/l)	As/Cl
<u>10/19/83 Sample Set</u>																	
GM-0	6.9	678	1.2	425	212	259	19	84	-	-	-	-	-	-	-	-	-
GM-1	7.1	1158	9.0	650	602	734	18	<10	122	1.4	100	29	0.1	1.0	11.5	<0.5	6.8
GM-2	7.0	1355	5.7	758	596	727	79	<10	172	3.0	99	23	0.9	1.7	13.4	<0.5	2.2
GM-6	7.3	1050	7.4	635	207	253	61	188	97	2.7	98	16	<0.1	0.7	8.5	<0.5	1.6
Hg Pond	11.6	91625	4.0	85950	1424	1737	49000	1640	35200	19.4	13	<1	<0.1	<0.02	31.4	347	0.72
<u>10/27/83 Sample Set</u>																	
GM-0	7.1	719	1.4	485	202	246	27	84	-	-	-	-	-	-	-	-	-
GM-1	7.2	1178	8.1	675	599	731	49	<10	123	1.5	103	28	10.7	1.1	11.8	0.5	2.5
GM-2	7.0	1369	3.1	743	579	706	84	<10	203	3.2	92	21	5.1	1.5	13.8	<0.5	2.4
GM-6	7.2	1055	5.5	610	202	246	69	177	X	X	X	X	X	X	X	X	X
Hg Pond	12.0	61500	3.9	52400	5854	7142	29000	840	22000	17.4	16	1	0.1	<0.02	19.3	350	0.76
<u>Mean Average of 10/19/83 and 10/27/83 Data</u>																	
GM-0	7.0	699	1.3	455	207	253	23	84	-	-	-	-	-	-	-	-	-
GM-1	7.2	1168	8.6	663	601	733	34	<10	123	1.5	102	29	5.4	1.1	11.7	<0.5	3.6
GM-2	7.0 ↓	1362 ↑	4.4 ↓	751 ↑	588 ↑	717 ↑	82 ↑	<10 ↓	188 ↑	3.1 ↑	96 ↓	22 ↑	3.0 ↑	1.6 ↑	13.6 ↑	<0.5	2.3 ↑
GM-6	7.3	1053	6.5	623	205	250	65	183	97*	2.7*	98*	16*	<0.1*	0.7*	8.5*	<0.5*	1.6*
Hg Pond	11.8 ↑	76563 ↑	4.0 ↓	69175 ↑	3639 ↑	4410 ↑	39000 ↑	1240 ↑	28600 ↑	18.4 ↑	15 ↓	<1 ↓	<0.1 ↓	<0.02 ↓	25.4 ↑	349 ↑	0.73 ↓

- Not analyzed X

X Insufficient sample volume for analyses

\* Value based entirely on 10/19/83 data



TABLE 3  
Organic Analysis of the Hg Pond and Downgradient Wells

	<u>TOC</u> (Analysis in ppm)		
	<u>8/3/83</u>	<u>10/19/83</u>	<u>10/27/83</u>
Hg Pond	--	4.0	3.9
GM-1	12	9.0	8.1
GM-2	--	5.7	3.1
GM-6	--	7.4	5.5

	<u>Halo-Org &amp; Benzene</u> (analysis in ppb)		Natrium Mercury Pond
	<u>8-3-83 EPA</u>		
	<u>GM-1</u>	<u>GM-6</u>	<u>3/23/84</u>
Methylene Chloride	10	11.1	4
Trans-1,2-Dichloroethane	ND	ND	<1
Chloroform	.916	1.60	6
Cis-1,2-Dichloroethane	25.4	53.4	<1
Carbon Tetrachloride	1.27	2.12	<1
Benzene	4.10	7.0	20
Trichloroethane	10.7	24.2	3.0
1,1,2-Trichloroethane	11.0	24.5	<1
Tetrachloroethane	28.9	26.0	3
Bromoform	3.40	5.91	<1
1,4-Dichlorobenzene	5.0	8.0	<10
1,2-Dichlorobenzene	10.1	15.7	<10
1,1-Dichloroethane	ND	ND	<1
1,1,1-Trichloroethane	.688	ND	<1
1,2-Dichloroethane	25.4	53.4	<1
Monochlorobenzene	ND	ND	<10
1,1,2,2-Tetrachloroethane	ND	ND	<10
1,3-Dichlorobenzene	ND	ND	<10
Hexachloroethane	ND	ND	<10
1,2,4-Trichlorobenzene	ND	ND	<10
1,2,3-Trichlorobenzene	ND	ND	<10
Unknowns			<10
Volatiles	ND	ND	
Aromatics	ND	ND	

ND = none detected

Analytical method on following laboratory report

## 2.0 WELL INSTALLATION AND SAMPLING AND ANALYSIS PLAN

### 2.1 INTRODUCTION

In the review of the detection monitoring data from the Mercury Pond, PPG recognized that the comparison of the background well (GM-0) with the three downgradient monitor wells (GM-1, GM-2, and GM-6) may result in false positives with respect to the monitored parameters. Recent comments from State regulators also convey this concern as well as a concern with the placement of the three downgradient monitor wells which the state alleges may not insure immediate detection of effluent releases from the Mercury Pond facility. Finally, on March 8, 1984, the U.S. EPA filed a complaint against PPG pursuant to RCRA essentially adopting the position of the State on well locations and further alleging violations of procedural requirements under RCRA.

In order to resolve these concerns, avoid litigation and prolonged proceedings, and create a reasonable monitoring program acceptable to all parties, PPG agreed to prepare a modified plan which would address the agencies' concerns and result in a plan more specifically tailored to the facts at the mercury pond.

### 2.2 WELL INSTALLATION PLAN

PPG proposes another attempt to establish a background monitor well topographically upgradient from the Mercury Pond. Although PPG and its consultant made a reasonable judgment in 1981 that the water table was not accessible in this area, this action will satisfy the concerns of the state and EPA that PPG "insure" that no topographically upgradient well is possible. To achieve this, PPG will install two additional wells straddling the original upgradient well GM-3 in the area above the pond (See Figure I - Points A & B).

Installation of these two additional wells topographically upgradient is an attempt to discover a discrete section (i.e., an incursion of the water table on the bedrock) with a sufficient yield for sampling. These wells are expected to be dry and unsuitable for monitoring, but will provide assurance that no upgradient well is possible in the immediate vicinity of the pond.

If these wells fail to produce an adequate groundwater supply for monitoring purposes, an alternative location will be selected for the installation of the background well. This alternative background well location will be somewhere along the base of the valley wall, north of the pond, in the same aquifer as the downgradient well and far enough from the pond to insure that the aquifer is not affected by extraneous constituents or the pond itself (See Figure 1 - Point C).

One of these three wells will be selected for background monitoring depending on yield and conditions.

The agencies also raised a concern about whether two of the existing three downgradient wells (GM-1 and GM-6) were too far apart. PPG feels that these wells are adequate to detect any leaks from the pond, but to satisfy these concerns, an additional well will be installed roughly midway between existing wells GM-1 and GM-6 (See Figure 1 - Point D). Since there has also been concern on the part of the state of any perched water zones, a neighboring, shallow well will also be installed if a perched zone is encountered during drilling of the deeper well (See Figure 1 - Point E).

All of the new deep wells would be installed to bedrock; well depths are anticipated to be about 50 feet at the upgradient locations (Figure 1 - Points A&B) and about 90 feet at the other locations (Figure 1 - Points C&D). These wells will be constructed using two-inch-diameter PVC casing and well screen, and will be fully penetrating (i.e., screened from the top of the water table down to bedrock - See Figure 2).

Monitor wells will utilize formation collapse and/or clean silica sand as the screen pack material. This pack shall extend at least 10 feet above the top of the well screen. The screen pack shall be capped with a plug (at least one-foot thick) of bentonite, or bentonite and neat cement to prevent seepage of surface fluids into the well. Formation cuttings will then be used to fill the borehole annulus to a level at least five feet below ground, and a cement plug will be installed up to ground level. All above-ground well casing shall be protected with steel covers.

*How drilled*  
*wrong pack material or sand 265.91(c)*  
*wrong cement same 265.91(e)*

PPG will continue to use the existing monitor wells which have been utilized for RCRA compliance to date. These include downgradient monitor wells GM-1, GM-2, and GM-6 whose locations are shown on Figure 1. These wells are installed into alluvial deposits to depths of about 96, 99, and 75 feet, respectively, and are each equipped with a ten-foot-long screen section that intercepts the water-table aquifer (See Figure 2).

*These wells  
do not comply  
with 265.91(c)*

### 2.3 SAMPLING AND ANALYSIS PLAN

Facilities to be included in the sampling and analysis program include: existing downgradient monitoring wells GM-1, GM-2, and GM-6; the new deep downgradient monitor well (Figure 1 - Point D) and one of the new background wells (Figure 1 - Points A, B or C). All samples shall be collected in accordance with the document titled "Sampling and Analysis Plan for the PPG Mercury Pond, Natrium, West Virginia," which was prepared by Geraghty and Miller, Inc., in 1981 and submitted to both state and federal agencies.

?

As described in Section I (Background Information) the utilization of specific conductivity, TOX and TOC parameters cannot accurately characterize any leakage emanating from the pond and any attempt to use these parameters results in false positives under the applicable regulations. In initial discussions with EPA Region III, PPG indicated that sulfide might be a suitable parameter to analyze in downgradient monitoring wells to detect leakage. After further consideration, it appears this would not be a good choice. The pH range necessary for effective operation of the pond, necessitates maintaining the sulfide content between 0 and 1 ppm. Higher levels of sulfide form mercury polysulfides which are soluble. Most or all of this sulfide excess will be oxidized in the pond and would not reach the monitoring wells even if a leak occurred.

PPG proposes the use of two key chemical constituents which truly reflect the composition of the pond waters. These include:

pH - Since the fluids in the Mercury Pond have a very high pH (11.6 to 12.0); and,

Mercury - Since dissolved mercury is present at appreciable levels in the pond fluids (about 350 mg/l).

Evaluation response and reporting of this data will continue to follow the prescribed methods as specified under 40 CFR 265.93 and 265.94.

To examine the perched water zones, PPG also plans to monitor all existing shallow wells GM-3, GM-5 and GM-7, a new shallow well (Figure 1 - Point E) if a perched water zone is encountered while installing the new deep downgradient well, and any existing and active seeps adjacent to the pond. These samples will also be analyzed for both pH and mercury under the same program. Collection and evaluation of this data, however, will be dependent on adequate sample volumes. A summary of this program is presented in Table 4.

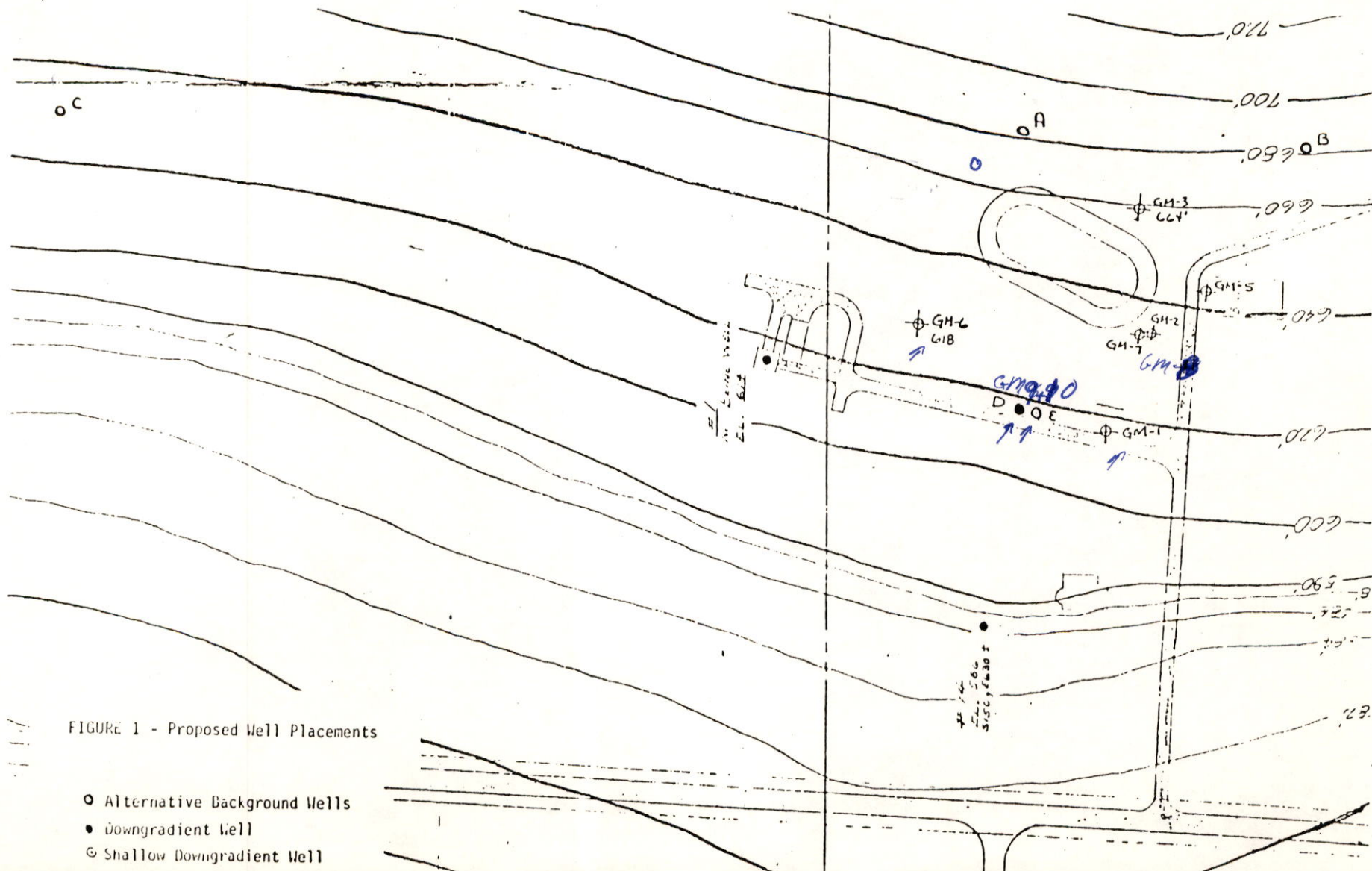
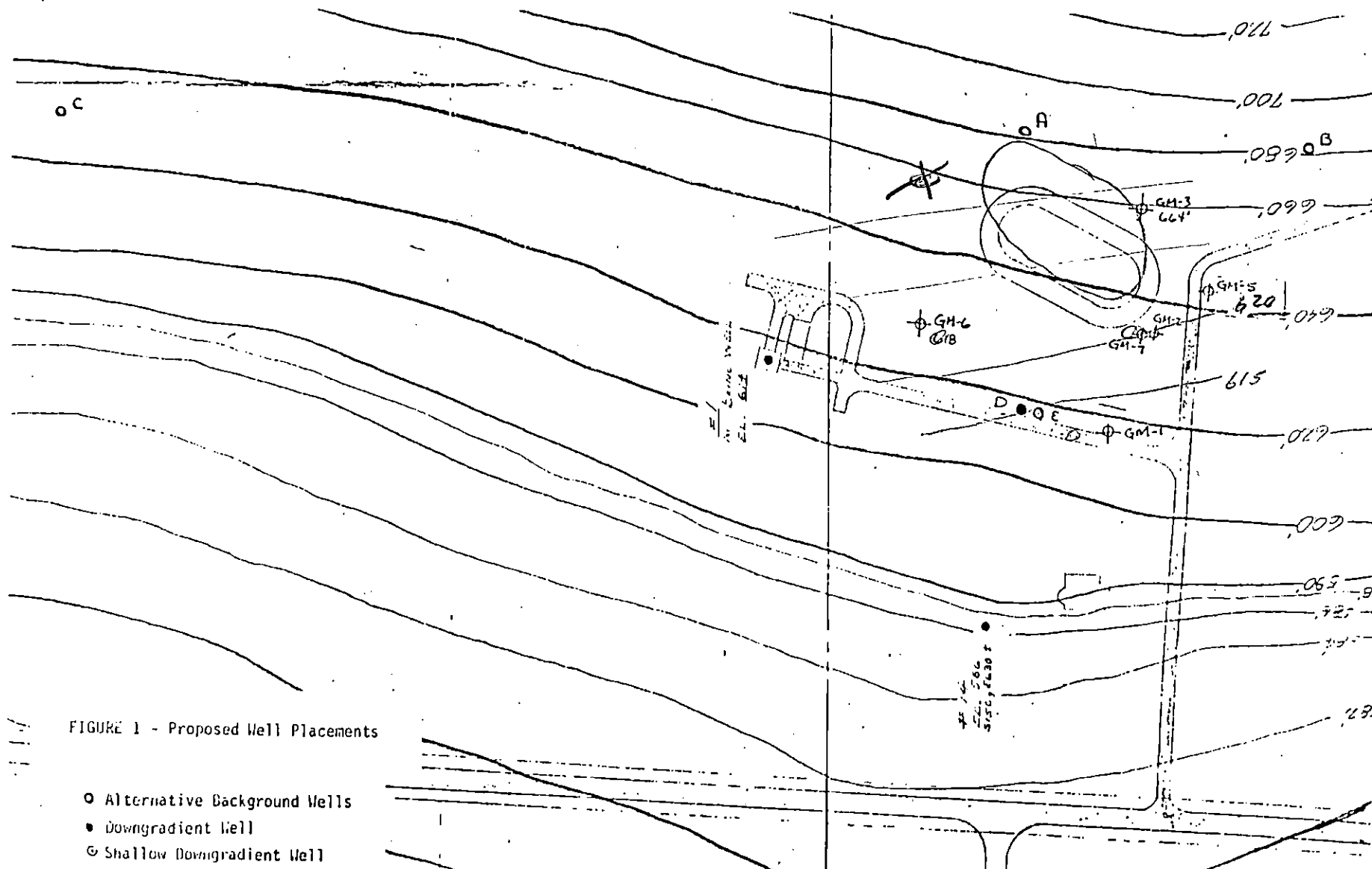
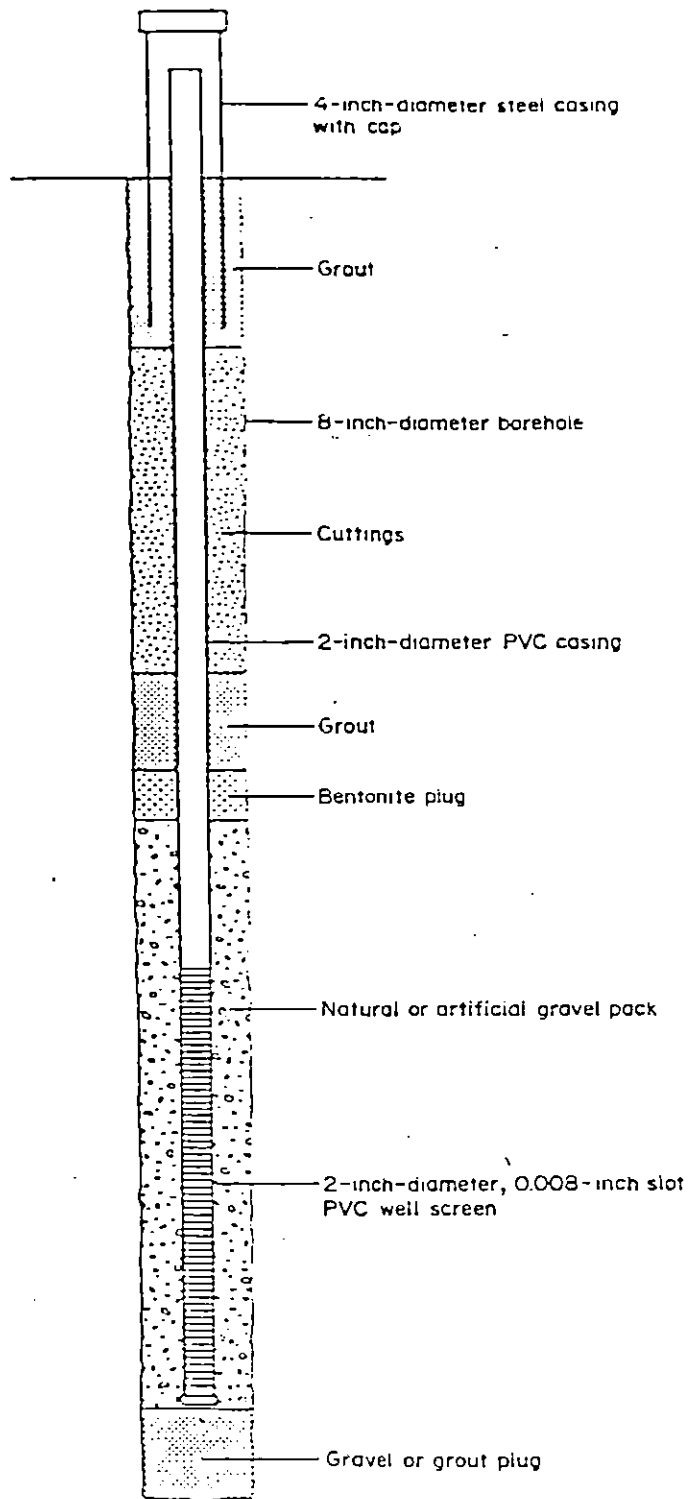


FIGURE 1 - Proposed Well Placements





Well Number	Elevation* (ft)	Total Depth* (ft)
GM-1	693.10	99
GM-2	709.88	102
GM-6	696.90	78

\* Measurement from top of outer casing.

Figure 2. General Construction of Downgradient Monitor Wells, PPG, Natrium, West Virginia.



TABLE 4  
SAMPLE COLLECTION AND ANALYSIS PLAN

Parameter	New Upgradient & Downgradient Wells	GM-1, GM-2, GM-6	GM-3, GM-5, GM-7, Seeps
-----------	----------------------------------------	------------------	-------------------------

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A. First Year

pH	4 replicates each quarter	4 replicates each quarter	4 replicates each quarter
Mercury	4 replicates each quarter	4 replicates each quarter	4 replicates each quarter

B. Second Year

pH	4 replicates twice/year	4 replicates twice/year	4 replicates twice/year
Mercury	4 replicates twice/year	4 replicates twice/year	4 replicates twice/year

### 3.0 SUMMARY

The primary objective of this modified monitoring plan is to address the concerns expressed by the state and federal agencies notwithstanding the fact that the current well system is, in PPG's opinion, adequate. To achieve this, a number of new wells will be installed. In addition, parameters selected in this proposed program were chosen as those constituents which could accurately characterize any potential leakage and eliminate false positives under the RCRA regulations.

The key components of this modified plan primarily consist of the following:

- Installation of two additional topographically <sup>hydraulically</sup> upgradient wells in an attempt to discover a discrete section with sufficient water yield for sampling. These two wells are expected to be dry and unsuitable for monitoring, but will at least provide assurance that no upgradient well is possible in the immediate vicinity of the pond.
- Installation of one "upgradient" well to the north of the pond which should contain groundwater in the same aquifer and lithology as the downgradient wells, but which does not actually pass under the impoundment. One of these three upgradient will be selected for monitoring if yield and conditions are satisfactory.
- Installation of one downgradient well, essentially midway between two of the existing three wells (GM-1 and GM-6). This well will be completely screened in the aquifer/water table. *If you have*
- If perched water is discovered during the installation of the deep downgradient well, a neighboring, shallow well shall be installed and monitored for mercury and pH.
- All existing and active seeps will be monitored for mercury and pH.
- With respect to the wells, rather than monitor for pH, specific conductivity, TOX and TOC, PPG will monitor for mercury and pH. Specific conductivity, TOX and TOC result in false positives and should not be part of any monitoring program.

#### 4.0 REFERENCES

Geraghty & Miller, Inc., April 1981, Evaluation of Groundwater Quality Impacts at the PPG Mercury Pond, Natrium, West Virginia.

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Krauskopf, Konrad B., 1967. Introduction to Geochemistry: McGraw-Hill Book Company, New York.